

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
LIBRARY, P. S. TERMINAL
80 PARK PLACE, ROOM 8236
NEWARK, NEW JERSEY

CHEMISTRY

AC S REPORTS FROM THE AMERICAN CHEMICAL SOCIETY MEETING AT ATLANTIC CITY

	Page
ACS Presidential — Science Should Better Mankind	1
ACS In the Plastics Field	4
ACS Progress in Medicine	7
ACS Radioactivity and Fallout	15
ACS Fuel Research	18
ACS Food Chemistry	21
ACS Agricultural Chemistry	23
ACS Other Papers	26
Indicators from Flowers — STS Project	29
Chemistry Quiz	32
For the Home Lab: Oxides of Carbon 11	33
Chemical Patents	36
Preparing Molybdenum Chlorides	39
Science as a Social Goal	41
New Plastics Good at 15,000° F	44
On the Back Cover	45
Chemistry Comments	46
Book Condensations	47

Editorial:

Whither the Analytical Chemist?
Inside Front Cover

50¢

A SCIENCE SERVICE PUBLICATION

Whither the Analytical Chemist?

► FROM THE PAPERS presented at the American Chemical Society Meeting in Atlantic City this fall, and from numerous other publications, it would seem that the analytical chemist, as we know him today, is on the way out.

More and more the traditional laboratory analysis techniques are being replaced by automatic instruments into one end of which a small sample of the material under investigation is fed, while from the computer coupled to the other end there issues a card on which is coded the analysis.

Hitherto the analyst has been characteristically a neat, careful man, of infinite patience, and possessing a sound broad knowledge of chemistry. Now it appears that part of his work will henceforth be done by the physicists and electronic engineers of the instrumentation companies, while his place in the laboratory will be taken by mathematicians capable of interpreting the results obtained from computers.

Up to the present the majority of chemists employed by industry, and many of the greatest consultants in the chemical field, have been essentially analytical chemists. This revolution, should it take place, would surely have far-reaching results.

What is the moral in this? It is, perhaps, that the student, in preparing himself for a career in chemistry, should take care that he does not neglect mathematics and physics in favor of the more glamorous and perhaps easier fields of pure chemistry, or else he may find himself 'all dressed up with nowhere to go.'

CHEMISTRY

Vol. 33, No. 2

Formerly Chemistry Leaflet

October 1959

Including The Science Leaflet

Published monthly, September through April, by Science Service, Inc., the non-profit institution for the popularization of science. Publication Office: 326 W. Beaver Ave., State College, Pa. Second class postage paid at State College, Pa., and at additional mailing offices. Address subscriptions and editorial communications to the Editorial Office: 1719 N Street N.W., Washington 6, D. C.

\$4 a Year; Two-Year Subscription \$7; Your Own and a Gift Subscription \$7 a Year.

50¢ a Copy. Ten or more subscriptions to the same address: \$2.90 a Year each.

No charge for Foreign or Canadian Postage.

Editor: WATSON DAVIS

Assistant Editor: STEPHEN HISCOCKS

Consulting Editor: PAULINE BEERY MACK (Editor 1927-1944)

Editor in Memoriam: HELEN MILES DAVIS (1944-1957)

Copyright © 1959 by Science Service, Inc. All rights reserved. Science Service issues press service for newspapers and magazines, publishes Science News Letter (weekly), issues THINGS of Science (monthly) and administers Science Clubs of America.

Science Service is the educational and scientific institution organized in 1921 as a non-profit corporation with trustees nominated by the National Academy of Sciences, the National Research Council, the American Association for the Advancement of Science, the Scripps Estate and the Journalistic Profession.

Highlights from the
136th National Meeting
of the
American Chemical Society
at Atlantic City in September.

This report on the meeting includes the following summary of the presidential address by
Dr. John C. Bailar, Jr.

Science Should Better Mankind

➤ SCIENTISTS of America were exhorted by the president of the American Chemical Society to help meet the Cold War challenge by striving for the use of scientific discoveries "for the betterment of every human being in this entire world."

Unless American science has a higher goal than the mere production of more machines and materials to increase our own physical comfort, "we are sowing the seeds of our destruction," Dr. John C. Bailar, Jr. of the University of Illinois asserted in his presidential address.

The ACS president, who is professor of inorganic chemistry at Illinois, also appealed for more efficient use of all the nation's natural resources, human as well as physical, to preserve our leadership in world society. He specifically urged the strengthening of public school education, even if this means "tripling the salary budget in our high schools."

"Our adversaries behind the Iron Curtain boast that they will gain supremacy over us, not by force of arms, but by their greater diligence and by their willingness to sacrifice for their ideology, and it is possible that they will make good on their boast unless

we more fully utilize our neglected resources," Dr. Bailar said.

"History contains many a story of the replacement of civilizations by other, more vigorous ones, even though the latter seemed barbaric and uncouth. Our civilization need not follow that course, and it must not!"

It has been found, Dr. Bailar noted, that when the people of underdeveloped countries have an opportunity to enjoy the physical comforts made available through scientific research, they also gain a new and more hopeful outlook on life, a desire for education, and a kindlier attitude toward the world.

"Can this process not go on to higher and higher levels, so that with our increasing knowledge and improved methods of learning we can have not only better health and more physical comforts, but also a higher idealism, a greater appreciation of beauty, and a keener enjoyment of intellectual pursuits?" Dr. Bailar asked.

In recent years, he emphasized, mankind has gained tremendous power through the efforts of scientists, and the application of scientific knowledge can do vastly more good or infinitely more damage than ever before.

ACS Meeting

"Scientists accept credit for discoveries which are purely beneficial, such as the development of pain-killing drugs, but they often try to avoid the social implications of scientific discoveries which have been used in evil ways," he observed. "Science itself is neither good nor bad, but the products of scientific development can be used in either good ways or evil ways, and scientists cannot long avoid responsibility for the use or misuse of the power which they have created."

"As scientists and as citizens, each one of us must individually do his utmost to see that scientific discoveries are used, not for the destruction of mankind, but for the betterment of every human being in this entire world."

Dr. Bailar, whose topic was "The Utilization of Our Natural Resources," asserted that the Cold War entailed just as great a strain on these resources as did World War II. He stressed the importance of conserving the nation's physical assets — fertile soils, forests, coal, petroleum, natural gas, and the like — some of which, he noted, have been "ruthlessly squandered."

Of even greater significance, however, are the country's human resources, which also have sometimes been "wasted thoughtlessly," Dr. Bailar declared. Among these resources he listed intellectual ability, initiative, imagination, and accumulated knowledge.

"As the store of human knowledge grows, and with it our power over nature," he continued, "these human resources become ever more important, and unless we see to it that each

person in our country utilizes his innate latent resources to the best of his ability, we shall surely lose our place of leadership in world society."

Early American schools were devoted almost entirely to the teaching of the intellectual disciplines, and the pupils learned homemaking, farming, and mechanics outside school, the speaker pointed out. As our social system has evolved, however, the schools have added to their offerings in the intellectual subjects a great variety of courses designed to prepare students for specific trades, as well as courses in homemaking, family living, driving training, and the like.

"For some students," Dr. Bailar commented, "a high school education now consists of little more than learning how to drive a nail, how to drive a car, and how to drive a bargain."

Urging renewed emphasis on such subjects as the basic sciences, history, economics, and foreign affairs, Dr. Bailar deplored the "erroneous" hypothesis that only a small percentage of our young people can learn science, mathematics, and foreign languages, and that the rest can be taught only subjects of less challenging intellectual content.

"This is a startling suggestion," he said, "especially when statistics show that more than half of the children in Europe, both in front of the Iron Curtain and behind it, are enrolled in courses in the intellectual disciplines. Should we assume that our children are less able than those in Europe? If only a small percentage of our young people are capable of intellectual pursuits, can we continue to believe in and practice universal suffrage?"

frage? If the great majority are incapable of mental discipline, dare we entrust them with self-government? If our high schools have failed to give the pupils an intellectual training, must we assume that the failure is due to the low mentality of the pupils?"

"By no means!" was Dr. Bailar's answer; it can be assumed equally well that the school, rather than the pupil, has failed. Although there are many able, well prepared, and devoted teachers in the public schools, he explained, there are also many who have no real love for scholarship and who possess only a superficial knowledge of the subjects they are assigned to teach.

He said the fault often lies with state education departments which do not require adequate preparation of teachers in the subjects they are to teach.

The American Chemical Society has done much in recent years to strengthen the teaching of chemistry, both nationally, through sponsorship of chemistry films, and at the local level, through cooperation by ACS local sections with the schools in their communities, he pointed out, urging all sections of the Society to join in these activities. Dr. Bailar also praised the Science Teachers Institutes sponsored by the National Science Foundation.

Much more, however, needs to be done, according to Dr. Bailar, who said:

"The need cannot really be met until the American public fully understands that persons of the requisite ability can be attracted into high

school teaching only if they are accorded the same social and financial rewards as doctors, lawyers, and other professional men. This may mean tripling the salary budget in our high schools, but if we believe the fundamental postulate of democracy — that every person must be helped to develop himself fully — we cannot afford to entrust the intellectual development of our children to men and women who are less able than those who guard their health or their property."

He termed it "most disturbing" that so many students with superior records in high school do not go to college.

He commended Congress for appropriating scholarship funds, but expressed concern lest government aid weaken the fundamental American principle that the goal of education is the improvement of the individual's lot in life.

Reorganization of the college chemistry curriculum is required, Dr. Bailar said, to meet the needs of an age in which chemical knowledge is accumulating far too fast for any student to master more than a fraction of it.

He also called for greater emphasis on fundamental research, which seeks knowledge for its own sake, to prevent depletion of the store of basic information from which applied chemistry draws in solving practical problems.

Efforts to speed publication of knowledge obtained under classified government contracts and in the laboratories of industrial concerns were also urged by Dr. Bailar.

In the Plastics Field

Tough Plastic from Sugar

➤ A NEW PLASTIC, cheaper and better in many ways than widely used phenolic materials, has been made with common table sugar.

The strength of the new substance under bending, stretching, and impact is equivalent to or better than that of standard filled phenolic resins, said Robert P. Cox, a research chemist of the Bjorksten Research Laboratories for Industry, Inc., Madison, Wis.

The superior plastic resin is made by using sucrose (table sugar) to replace some of the phenol (carbolic acid) that goes into phenol-formaldehyde resins. Although the new resin contains as much as 40 per cent sucrose, it is not susceptible to water.

Another advantage of the sugar resin is that it does not acquire a charge of static electricity when rubbed, as do many plastic materials, Mr. Cox said.

For tests of its properties, the sugar plastic was combined with wood flour in standard formulations employed for phenolic resin. Phenol-formaldehyde compounds are used for radios, telephones, electronic parts, toasters, cookware handles and a variety of other products for defense, industrial and household uses.

The cost of the sucrose resin is 10.7 cents a pound, four cents less than the cost of straight phenol-formaldehyde resin. This figure could be lowered further by a possible reduction in price of sucrose used for large scale industrial purposes.

It is believed that the resins will find application in the fields of paper

and wood impregnation, assembly and plywood binding, injection molding, and foundry core bonding.

Sugar also is the raw material for another new product announced by William M. Gearhart of Eastman Chemical Products, Inc., Kingsport, Tenn.

Sucrose, properly combined with acetic anhydride and isobutyric anhydride, yields a product that improves certain plastics, films and protective coatings.

Known chemically as sucrose acetate isobutyrate or SAIB, the new material was said to make the plastic substances easier to handle during manufacturing. It promotes softer flow of plastics during extrusion without affecting hardness, scuff-resistance, adhesion, or gloss of the finished product.

SAIB is a clear, colorless, entirely odorless material. Unlike its parent chemical, sucrose, it will not dissolve in water, although it readily dissolves in many commercial solvents. At room temperature it resembles an extremely thick syrup. But one of its unique properties is that it rapidly becomes pourable as the temperature is increased.

This new compound has shown promise as an extender in lacquer and melt coatings for cloth, wood, paper, plastics, and metal, and as a modifier in extrusion molding formulations of cellulose acetate.

Such properties indicate a potential value of sucrose acetate isobutyrate to the film and plastics industries.

Plastics in Rocketry

► PLASTICS may get the roughest job in rocketry. Already used in nose cones, insulation, and the body structure of rocket motors, reinforced plastic materials are now under test for the most punishing position of all — the rocket nozzle, according to George Epstein, head of research and process development for Aerojet-General Corporation's structural plastics division, Azusa, Calif.

A series of laboratory tests with a hydrogen-oxygen rocket motor at temperatures exceeding 5,000 degrees Fahrenheit has led to the following conclusions:

1. Reinforced plastics can be used successfully in nozzles of rocket motors provided the designer takes into consideration the changes that occur because of "ablation," the progressive burning and blasting away of the surface of the nozzle. The extent of ablation is determined by the temperature, the pressure reached in the rocket blast and the time of exposure.

2. This wearing away of the plastic rocket nozzle also depends, on the kind of plastic used, the material employed for reinforcing it, and the direction in which the reinforcing is placed.

3. Logically, the heat-resistant types of plastic seem to perform the best, with phenolic and phenolic-silicone types lasting longest at test temperatures of 5,400 degrees.

4. The best reinforcing material to date is "Refrasil," a fabric made of silica, cut in half-inch squares. Ceramic tape, "E" glass fabric, glass-copper tape, stainless steel screen, asbestos matting, brass screen and nylon fabric

also were tested. Various kinds of powdered fillers and chopped-fiber reinforcing were tried without benefit.

5. Best results were obtained when the little squares of fabric were at right angles to the rocket blast. Material laminated parallel to the gas flow tends to fail because of "interlaminar stresses" and peeling of reinforcement layers.

6. Attempts to protect the surface of the plastic nozzle with thin ceramic coatings failed. Pieces of the coating broke off, interrupting the rocket blast and causing rapid destruction of the nozzle.

7. In fabricating the nozzles, the temperature, pressure and time of molding have a remarkable influence on the properties of the reinforced plastic. Preliminary tests indicate that phenolic-Refrasil nozzles may be improved markedly by increasing molding pressure.

Advances in the space age demand an ever increasing improvement in materials, processes and designs for rocket motors and components. In the case of rocket nozzles, it is extremely desirable to achieve lighter weight units that will maintain their dimensions during firing.

In solid propellant rocket motors, the nozzle is generally uncooled. That is, the propellant or heat transfer liquid is not available to be channelled through the nozzle walls to absorb the heat, as in many liquid propellant engines. Consequently, the exposed surface of the rocket nozzle is subjected to very severe thermal fluxes and mechanical erosion effects from the extremely hot, high velocity,

propellant combustion gases. Indeed, this environment produces possibly the most severe service conditions experienced to date.

Various limitations are encountered in the use of current nozzle materials. Some are heat-sink materials suitable only for short durations. Some are brittle and subject to chipping during operation. Some are very costly, available only in limited quantities, and many are extremely difficult to fabricate into the required shapes.

Previous experience had indicated considerable promise in the use of reinforced plastics under ultrahigh temperature, high gas-velocity environments. Accordingly, a nozzle development program was initiated to establish materials, processes, and design criteria to provide lighter weight nozzles that are dimensionally stable under the necessary service conditions.

Harry A. King, head of the Research section of the Aerojet-General research and process development department, was co-author of the report.

Plastics Production to Double

► THE U. S. PLASTICS industry will increase its production 100 percent over the next ten-year period to reach in 1970 an annual production rate of almost 11 billion pounds, Paul Mayfield, vice president and director of Hercules Powder Company, Wilmington, Del., forecast.

"The surge ahead for plastics in the sixties will embrace many new developments. Most of the new markets will be new applications," Mr. Mayfield said. As one example of increased plastics consumption by just one segment of the U. S. economy, the automotive industry in 1958 con-

sumed 100,000,000 pounds of plastics, and in 1965 is forecast to use 200,000,000 pounds.

In the next ten years, plastics will replace, for certain uses, steel, bronze, aluminum, and glass. Other industries which will use increasing amounts of plastics materials are packaging, film, household appliances, and home construction.

Not only will plastics quality improve in the sixties, as in the past, but the dynamic sixties will see continued growth in the happy marriage of plastics with plastics, and plastics with nonplastics materials. Products have evolved that were never possible with either material, and have opened new avenues of product development.

Mr. Mayfield said that polyethylene will soon be the first billion-pound plastic, and by 1965 the newest plastic material, polypropylene, now produced only by Hercules, will be approaching billion-pound production.

Inorganic "Rubber"

► THE BREAKING of heat barriers that limit land, sea and space travel and hamper technological progress in many areas is foreseen in the development of a new kind of "rubber."

A new polymer, a material made of giant, chain-like molecules, containing only zinc, chlorine, and ammonia has been developed which appears to have limited elastomeric (rubber-like) properties, said Joseph Simkin of the Pennsalt Chemicals Corporation.

This achievement is thought to be remarkable because, so far, plastics and rubber-like materials have been made only from organic (carbon-containing) polymers. In general the inorganic, or non-carbon, substances do

not form polymer molecules and cannot be produced in rubbery form. Many inorganic substances resist higher temperatures than do the organic compounds, however, and researchers are seeking products that combine the elasticity of organic polymers with heat resistance.

Present operating temperatures for many devices are about at the limit organic polymers can withstand. The program is aimed at the exploration of the possibilities of raising this limit by making inorganic polymers.

These results are only a beginning in the problem of synthesizing a useful polymer not containing carbon. The thermal stability and the hydrolytic (water resisting) stability leave much to be desired. The task remaining is to make and evaluate a large number of them in the search for the

specific properties of thermal stability and elastomeric nature desired.

The preparation of the new polymer material, known chemically as polymeric monoaminedichlorozinc, encourages the belief that it is possible to make new kinds of polymers. The new product is an amber-colored, transparent, glassy material at room temperature. It softens upon heating and becomes a heavy syrup at about the boiling temperature of water. When just molten, the material can be drawn into fine filaments which exhibit plasticity and flexibility after cooling, and films of the polymer adhere well to aluminum and glass surfaces.

Dr. B. Peter Block, research group leader in the Pennsalt Inorganic Research Department, was co-author of the report.

Progress in Medicine

How Virus Attacks Cell

► THE CHAIN of events that accompanies a viral invasion, whether of a human being, an animal, a plant or a bacterium, was detailed by Dr. Lloyd M. Kozloff, associate professor of biochemistry of the University of Chicago. He investigated the infection of a bacterium, called *Escherichia coli* by a virus known as *bacteriophage T2*. The added knowledge of viruses is expected to aid in the fight against viral infections and may give insight into the mysteries of life's creation.

The head of the tad-pole shaped virus has a core of nucleic acid (DNA). The tail is a tube surrounded by a spiraled protein casing. Nucleic acids are the infectious portions

of viruses. When the virus attaches itself tail-first to the bacterium's cell wall, the coiled proteins of the tail casing contract, forcing the protein core of the virus tail into the cell body.

In the first step, the virus attaches itself to its unwitting host through an electrostatic attraction between the protein in the virus and chemical groups on the host surface. Next, zinc in the outer cell wall reacts with sulfur in the tip of the virus tail and the protein sheath contracts. Then an enzyme in the tail dissolves the outer cell wall.

The way in which the nucleic acid pierces the inner cell wall is still uncertain, but it may be that the spring-like contraction of the virus tail is

strong enough to force the DNA through the thin inner membrane of the cell.

"Although the forces responsible for the infection of the viral DNA have not been definitely defined, recent experiments indicate that changes in the head structure are involved," Dr. Kozloff explained. "The head of bacteriophage T2 has been found to exist in two alternate forms, a relatively long form and a shorter, thicker form. During injection, the head configuration changes from the long form to the shorter form. This change in configuration appears to be closely associated with the release of DNA from its protein covering and its passage into the host cell."

New Drugs from Rocket Fuel

► POWERFUL new agents for lowering blood pressure have been made by combining conventional hypotensive drugs with the rocket fuel hydrazine. The new compounds are not yet available for use in human therapy.

Uniting the drug pentolinium dibromide with hydrazine increases its hypotensive action in dogs by 200 per cent, Dr. John H. Biel, director of Lakeside Laboratories, Inc., Milwaukee, Wis., reported.

The new compound produces a 39 percent decrease in blood pressure in the animals for as long as five hours. Two other compounds capable of reducing blood pressure by more than 26 per cent for two-and-a-half hours also were described. Clinical tests have not been completed.

Just a year ago, at the American Chemical Society's fall meeting in Chicago, Dr. Biel reported the synthesis of hydrazine compounds that

are strong stimulants against mental depression and fatigue. One of them is now on the market under the trade name Catron.

The compounds reported were synthesized by substituting hydrazine for methylene and ethylene groups, in hypotensive drugs of the bis-ammonium alkane class, Dr. Biel explained. Some of their effectiveness stems from an ability to block the ganglia, or nerve centers, which receive and send out nerve impulses. Other unexplained mechanisms also are probably involved.

Laboratory investigation indicates that some of the new agents prevent salt retention in the body by inactivating aldosterone, one of the body's most powerful salt-retaining compounds.

The known effect of hydrazine on aldosterone was one of several considerations leading to the new investigations. Strong blood pressure lowering agents have been prepared previously from bisammonium alkanes, but some of them cause such undesirable effects as dry mouth, pupil dilation, intestinal weakness and salt retention. Subsequent research, in which the structures of the compounds were chemically altered, led to increased potency and to the development of a type that was free of bad side effects. The present work was concerned with further structural modifications.

The incorporation of hydrazine into structural skeletons with an already high affinity for certain blood pressure regulating centers appeared to be a logical approach to the development of more versatile hypotensive drugs.

Hexamethonium and pentolinium, fortified with hydrazine, showed an increase in action and duration of hypotensive response over the parent compounds.

Two forms produced potent diuretic effects, which indicate this type may possess aldosterone-inhibiting properties.

Another series, in which the position of the hydrazine derivative was changed, caused prolonged blood pressure lowering activity, especially after oral administration. A third manipulation in chemical positioning brought forth a series which included two especially potent compounds capable of reducing blood pressure more than 26 per cent for 2½ hours.

Dr. Alexander E. Drukker, also of the Lakeside Laboratories, was co-author of the paper.

Assess Antibody Power

➤ A NEW TECHNIQUE for measuring the power of the blood's antibodies to combine with disease agents was reported by Dr. Alfred Nisonoff, a biochemist of the Roswell Park Memorial Institute, Buffalo, N. Y.

The method is based on the use of the active material in meat tenderizer which breaks up the antibodies into fragments. Antibodies fight bacteria, viruses and other disease-producing protein materials by attaching themselves to the invading agents and making them harmless.

The antibodies have been split neatly into three parts by the use of papain, the active ingredient of meat tenderizer, the biochemist said. This first step was accomplished last year by Dr. R. R. Porter of England. Two of the portions were found to retain

their original ability to combine with foreign proteins. The third was found to be inert.

"We have now developed chemical techniques which permit the rapid isolation of active fragments of antibody molecule and enable us to assess their combining power," said Dr. Nisonoff.

"We have been able to demonstrate that the two critical combining regions of the fragments of rabbit antibody were just as active as those in the original unbroken antibody molecule. The main value of this technique is that it should enable us to produce and isolate still smaller active segments of antibodies."

Even the fragments are immensely complicated protein materials, which will have to be broken down into much simpler substances before their chemical structure and behavior can be understood.

Agents other than papain also have been shown to reduce the size of antibodies without destroying their activity, the speaker said, but papain is the only one that is known to separate the two combining regions of the antibody molecule.

"Ultimately the purpose of this work is the determination of the structure of antibody molecules, especially in the area of the combining region," Dr. Nisonoff commented. "Such information would give us better understanding of how antibodies combine with bacteria, viruses and other disease-producing entities."

Dr. Donald W. Woernley, a biophysicist of the Roswell Park Memorial Institute, was co-author of the report.

Chemical May Treat Peptic Ulcers

➤ SEAWEED EXTRACT as a medicine for treating peptic ulcers is a possibility, according to Dr. John C. Houck, director of the Children's Hospital biochemical research laboratory, Washington, D. C.

Carrageenin, a sulfated polysaccharide, that composes 60% to 70% of dried seaweed, apparently interferes with the development of ulcers by blocking the action of pepsin, Dr. Houck found in animal experiments. The chemical is not ready yet for human trials.

T. Lee and J. Bhayana of Georgetown University Hospital, Washington, D. C., were co-authors of the report.

Antibiotic from Thailand Soil

➤ A NEW ANTIBIOTIC from a Thailand soil sample, reported to have promising possibilities in both agriculture and medicine, was described by Dr. Robert L. Hamill, senior biochemist at Eli Lilly and Company, Indianapolis, Ind. The new agent, called tylosin, is now under clinical test.

Preliminary animal tests indicate that tylosin stimulates growth in both swine and poultry and retards the growth of bacteria that cause chronic respiratory infections in poultry. The drug, which is now being tested for its value in a wide variety of animal and plant diseases is being investigated clinically for its effectiveness against staphylococcus and streptococcus infections.

In the search for new antibiotics, soil samples are obtained from all over the world. One such sample was received from Thailand. From this soil

was isolated a new strain of *Streptomyces fradiae* from which tylosin was produced.

A low concentration of the drug inhibited the growth of a number of gram-positive organisms, *Mycobacterium*, and a few gram-negative organisms. An interesting activity was exhibited against the pleuropneumonia-like organisms, which are inhibited by less than 0.1 microgram of tylosin per milliliter.

When allowed to stand in acidic solutions below pH 4, a new antimicrobial compound, desmycosin, is formed. It is very similar in microbiological activity to tylosin, inhibiting the same organisms at the same relative concentrations.

Pharmacological testing of the antibiotics has shown them to be relatively non-toxic. Rats fed one per cent tylosin in their daily diet for more than a year have normal growth rates and exhibit no pathological conditions. Dogs tolerate a daily dose of 100 milligrams per kilogram without effects.

Preliminary investigations in animals indicate that both compounds are effective when administered orally or parenterally against a number of infections. Clinical investigations have been initiated to evaluate the antibiotics in human beings.

Dr. Paul F. Wiley, Dr. Martha C. Stamper and Michael E. Haney, Jr., all chemists at the Lilly Company, were co-authors of the report.

Attempt to Starve Cancer Cells

➤ GROWING cancer cells are gluttons for glutamine, a prime building block for healthy cell components such as protein and nucleic acid.

This added insight into the chemistry of cancer has led researchers to seek "glutamine antagonists," according to Dr. Eugene Roberts, chairman of the department of biochemistry at the City of Hope Medical Research Institute, Duarte, Calif. Glutamine antagonists are substances that would interfere with a cancer cell's ability to devour glutamine.

Malignant tissues do not make glutamine fast enough to satisfy their own voracious needs. Instead, they strip the substance from blood cells into which normal tissues seem to spill some of the glutamine they form.

The quest for glutamine antagonists has grown out of a twelve-year study by Dr. Roberts and his associates in which they determined the distribution of free or loosely bound amino acids, such as glutamine, in plant and animal tissues. Glutamine was found in substantial amounts in all normal animal tissues studied, but in small amounts in cancerous tissue.

On the other hand, glutamine appears in considerable amounts in tumors whose growth is halted and those which are made to regress. This discovery focused attention on the role of glutamine in tumor metabolism and suggested that it might be possible to halt the growth of tumors by interfering with their use of glutamine.

The biochemist explained that, although successful interference with the use of glutamine by tumor cells could lead to their control or destruction, the strategy employed would have to include some method of decreasing the level of glutamine in blood as well as in the cell.

Work is in progress in many laboratories on substances which may be glutamine antagonists, some of which have already shown some promise.

Dr. Roberts and his co-workers made use of a chemical technique called paper chromatography in separating and identifying the amino acids extracted from the normal and tumorous tissues. The amino acids of the extracts are separated on sheets of filter paper by solvents and visualized by spraying with a chemical that locates each acid by forming colored spots.

By this procedure the scientists found that, in a particular animal species, each normal tissue had a highly characteristic pattern of free amino acid, which was different from that of other tissues. But a large variety of tumors from different animal sources all showed very similar patterns.

Dr. Roberts noted that these findings were in striking confirmation of an observation by the late Dr. Jesse P. Greenstein, noted biochemist and cancer researcher. Dr. Greenstein had observed that "no matter how or from which tissue tumors arise, they more nearly resemble each other chemically than they do normal tissues, or than normal tissues resemble each other."

Included in Dr. Roberts' studies were tissue samples obtained from human surgical specimens as well as from monkeys, dogs, cats, guinea pigs, rabbits, rats, mice, opossums, chickens, alligators, snakes, turtles, frogs, salamanders, and a wide variety of marine organisms.

Enzyme Balance in Cancer Cells

► THE DISCOVERY of high concentrations of sugar-fermenting enzymes in

cancer cells may help explain how cancer uses sugar to produce the energy for its wild growth.

In normal cells there is a delicate balance between the enzymes, or chemical regulators, that ferment sugar and those that help oxidize or burn it, but chemical investigations of cancer cells reveal ten times the normal concentration of certain fermenting enzymes, according to Dr. Efraim Racker of the Public Health Research Institute of the City of New York, Inc.

Researchers have long known that cancer cells ferment sugar to form unusual amounts of a material called lactic acid, but until now they have not known exactly why. Because they realized that the production of the acid might be an important clue to the growth of cancer, Dr. Racker and his co-workers undertook a detailed chemical analysis of the enzymes, cofactors, and regulatory mechanisms that govern the use of sugar by normal and cancer cells.

Both oxidation (burning) and fermentation of sugar in cells require certain chemical cofactors for proper functioning. The action of these cofactors is in turn regulated by the enzymes that ferment sugar, or those that help burn it normally to carbon dioxide and water. But whereas in normal cells the fermentation reaction is kept from getting out of hand by a proper balance of key enzymes, the balance is upset in cancer cells, and large amounts of lactic acid form.

Reviewing earlier work, Dr. Racker said that oxidation of sugars appears to take place in specific structures within the cell, called mitochondria.

Fermentation, on the other hand, is promoted *outside* the mitochondria by soluble enzymes. Both cell functions, oxidation and fermentation, also depend on certain cofactors, namely, inorganic phosphate and adenosine diphosphate (ADP). The present research shows that the mitochondria and the fermenting enzymes compete for these cofactors, and in cancer cells the fermenting enzymes get the upper hand.

In the most recent work, the mechanism by which the cells make inorganic phosphate (the fermentation cofactor) available to their enzymes, have been studied. The path of this cofactor from outside the cell into the cell proper is being studied with the aid of phosphate labeled with radioactive phosphorus-32.

These studies represent the beginning of a systematic approach to regulatory mechanisms of sugar metabolism. Since tumor cells metabolize sugar very rapidly and obtain most of their energy from this process, it is hoped a better understanding of tumor growth will be gained from these studies.

Drugs from Plant Cells

➤ PLANT CELLS from beans, corn, potatoes, roses and yams — many of them potentially useful as sources of food or drugs can be grown in tanks.

Such vat production of plant tissues containing useful chemicals would side-step the agricultural uncertainties involved in planting, cultivating and harvesting the plants, explained Dr. Nickell, a chemist of Chas. Pfizer & Company, Inc., Brooklyn, N. Y. The tissue-growing method resembles the growth of yeasts in beer mash and

the culturing of molds to produce antibiotic drugs.

One of the tissues propagated on a large scale at the Pfizer laboratories was taken from the Mexican yam, a fruitful source of drugs, including cortizone.

In addition to their work with the yam, Dr. Nickell and his associates have grown tissue from the Paul Scarlet rose, two kinds of potatoes, sweet corn, sorrel, holly, rye, yew, golden larch, ginkgo, pole bean, sunflower, cactus and century plant. In some instances stem cells were grown. In others, the original cells were taken from the root, leaf, pollen, tuber, or seed of the plant involved.

The laboratory-grown plant tissues were for the most part, produced in five-gallon glass jugs. They were submerged in liquid through which filtered sterile air was bubbled. In this way, about two plants of tissue can be grown in a month.

On a larger scale, as much as seven pounds of tissue were produced in a single run in fifty-gallon tanks. Nutrients used in the liquid media included coconut milk, yeast extract, sucrose, and vitamins B₁ and B₆. Rose, one of the most used experimental tissues, grew very well in a medium containing the well known weed-killer 2,4-D.

Although various plant tissues have been produced satisfactorily, Dr. Nickell emphasized that, up to this time, no attempt has been made to produce specific chemical compounds. Chemical analysis for drug intermediates such as alkaloids and sapogenins show that very little of these sub-

stances is present. Growth of the tissue itself is one obstacle successfully overcome: production of specific compounds is the next phase of research.

Advances of the type discussed here, plus those in other laboratories, have brought us close to the threshold of potential practical utilization of plant tissue culture.

It is hoped that these techniques can and will be used for the study of basic cell function, for the production of known desirable compounds, for the production of new compounds, in transformation reactions, and in mixed fermentation reactions for all of these possibilities.

Probably the most exciting prospects lie in the possibilities that such cells, freed from the restraints of being part of a multicellular, multifunctional organism, will in effect be a new group of microorganisms with all the capabilities which this encompasses.

Co-author of the paper with Dr. Nickell was Dr. Walter Tulecke also of the Pfizer Company.

Rebuild Diuretic for More Potency

► DELIBERATELY setting aside the experience of other chemists, five scientists of Chas. Pfizer & Co., Inc., have synthesized a series of potent experimental drugs which increase the body's excretion of water and salt.

Drugs of this kind, called diuretics, are important in the treatment of congestive heart failure, high blood pressure and other illnesses in which the retention of water causes complications. These include kidney disease,

the edema and toxemia of pregnancy, and liver disease.

The new compounds are known as benzothiadiazines, related to some diuretic drugs now used by physicians. Previous attempts to make chemical changes and improvements in such compounds, particularly at a site on the molecule called the C-3 position, had almost invariably made the drugs useless.

The Pfizer chemists nevertheless undertook to alter the basic benzothiadiazine structure at the C-3 position. They found that the key to successful changing of the molecule was the insertion of a sulfur atom in the side-chain at this position. The result of this structural change was the preparation of a whole series of new compounds, which show outstanding diuretic activity. More than 100 of these new compounds were made, 20 of which were described at the ACS meeting.

One such compound, named benzthiazide, was found to be between 4 and 16 times more potent in rats and dogs than is chlorothiazide, one of the most widely used diuretic agents. It is also a potent saluretic agent, promoting the excretion of salt. A patient with high blood pressure is often cautioned not to eat much salt. A drug that helps rid the body of excess salt allows the patient to maintain more nearly normal blood pressure.

Benzthiazide is now undergoing extensive clinical trials, and thus far appears to be a safe and highly effective drug for human use. It is taken by mouth and contains no mercury; though mercury compounds are effec-

tive diuretics and have been widely used as such in the past, they usually cannot be taken orally. Benzthiazide is not yet generally available to physicians.

Associated with Dr. J. M. McManus in the research were Dr. A. Scriabine and Dr. S. Y. P'an, pharmacologists, and Dr. W. M. McLamore and G. D. Laubach, chemists.

Drugs for Virus Ills Forecast

► "THERE IS NO reason to believe that drugs to treat virus diseases cannot be found," Dr. Jackson P. English of Lederle Laboratories, American Cyanamid Company told chemists.

"An active curiosity, the ability to plan and the energy to carry out experiments in the testing of imaginative concepts, and keen observation of all effects produced" have accompanied the great chemotherapeutic discoveries of the last fifty years and will improve the yield in the future, Dr. English said.

The closing of tuberculosis sanatoria and the saving of time and suffering formerly caused by pneumonia and septicemias are some of the benefits attributed in part to chemotherapeutic research in the past.

Perhaps the most significant accomplishment of the whole half century both in its own right and in its stimulating effect on the whole field, was the discovery of the sulfanilamide group of drugs in 1931. The demonstration that hitherto deadly diseases could be treated with success led to a feeling of optimism that has been largely responsible for the continuing

successes of chemotherapy. The circumstances of the discovery of Pron-tosil, the first sulfa drug, encouraged researchers to try large numbers of random compounds on experimental animals.

All of the examples of drug development have had at their beginning the observation of the activity of a lead compound, discovered either in the course of a screening program or by keen incidental observation. Unexpected findings in the search for better sulfa drugs led to the development of the first oral diuretic, oral drugs for diabetes, and iproniazid, a restorative drug for tuberculosis patients. Antifolic drugs which now delay the progress of leukemia, a fatal blood cancer, resulted indirectly from a theory developed to explain how the sulfa drugs work.

The antibiotics discovered in the rush of activity following the success of the sulfa drugs afforded control of many diseases, Dr. English recalled, citing Penicillin for syphilis and Streptomycin for tuberculosis. "The broad spectrum antibiotics continued the attack on the bacterial diseases and proved effective in the rickettsial diseases as well. The rickettsia (large viruses) had not even been separately identified in 1909."

Optimism, and a hundred-fold increase in the number of researchers is the principal difference between 1959 and 1909 in chemotherapeutic research. Fewer than 50 people were busy full-time on this work in 1909, but the basic principles and problems had already been sketched.

By 1909, Pasteur and Koch had

shown the bacterial and fungal causes of animal, plant and human disease. The malarial parasite, the spirochete of syphilis, and filterable viruses had been discovered. In 1889, Pasteur had coined the term "Antibiosis" for the ability of microorganisms of one kind to affect those of another kind. Biologists were producing experimental infections in animals and by 1911 an agent capable of saving mice from pneumococcal infection had been found. Quinine had been isolated and the structures of natural products were being determined. Ehrlich, discoverer of Salvarsan for syphilis, had elaborated a chemotherapeutic index for measuring the effectiveness of a drug and had advanced the concept that a drug must act directly on the infecting organism rather than at a distance. Drug resistance had already been encountered.

The compound sulfanilamide was known in 1910, but its value in treating infections was not demonstrated until 1931. Dr. English attributes the delay to Ehrlich's preference for vaccines and early reliance on test-tube rather than animal study of promising compounds.

Stimulation of research has been an important result of the successes of chemotherapy in the past fifty years, Dr. English concluded. "The ability to treat diseases economically, in the broadest sense, and therefore with profit to the manufacturer, has spurred a vast expansion in industrial pharmaceutical research with resulting benefits to human well-being through the contributions of drugs to human and animal health."

Radioactivity and Fallout

New York's Fallout Measured

► THE "HIGH LEVEL" of radioactive fallout on New York City during 1958, produced by three major series of nuclear tests, amounted to less than one hundredth of an ounce of material.

About this same concentration of "hot" isotopes, .01 ounce spread over New York's 315 square miles, fell at the same latitude across the United States, with lighter falls to the north and south, according to George A. Welford, an analytical chemist of the Atomic Energy Commission's Health and Safety Laboratory in New York.

Of seven major radioactive isotopes in this fallout debris, strontium 90 and cesium 137, feared because of their long-lived hazards to man, produced less than 2 per cent of the radioactivity. At the end of the year, the radiation from these two contributed 5.8 per cent of the total.

It is obvious that the shorter-lived isotopes contribute a large proportion of the total radiation and that they must be considered in any assessment of the dose delivered to the population from fallout, Mr. Welford pointed out.

Measurements of long range fallout debris began at the Health and Safety Laboratory early in 1951. The program was initially concerned with the assay of total radiation of beta particles at a sufficient number of sites to permit the estimation of world wide deposition. Accurate estimates of the strontium 90 content were made.

An increase in the number and fre-

quency of detonations and the advent of nuclear devices that introduced debris to the stratosphere caused many irregularities in the strontium 90 estimates. Therefore, direct measurement of the strontium 90 content through monthly pot collections on a world wide basis was begun in 1954.

The active isotopes strontium 89, strontium 90, cesium 137, tungsten 185, zirconium 95, cerium 144, and yttrium 91 arrived in New York during 1958, Mr. Welford reported. Analytical methods for detecting and measuring these materials and also barium and niobium isotopes were described. These radioactive substances were found in complex mixtures of the debris which also contained iron, silica and calcium.

Radiometric measurements were performed with Geiger counters and gamma scintillation detectors. Calculations and data analysis were performed by automatic data processing techniques.

Co-authors of the report with Mr. Welford were William R. Collins, Jr., Doris C. Sutton and Robert S. Morse, all of the AEC Health and Safety Laboratory.

Radioactive Strontium Removed from Animals

► PROGRESS in removing radioactive strontium from laboratory animals was reported by Harry Kroll, Ph.D., of Montefiore Hospital, New York. The elimination of radiostrontium from rats and mice is promoted by the injection of special compounds called chelates. Such substances trap

metals in solution and thus are able to interfere with their deposition in bone.

The most promising of the chelating agents was a compound known in chemical shorthand as BAETA. The agent was said to promote removal of radiostrontium from rats when it was injected soon after the animal received doses of the radioactive material.

These experiments, sponsored by the United States Atomic Energy Commission, were conducted on strontium-85, which has a half-life of 65 days. Strontium-90, a form encountered in fallout from nuclear bombs, has a half-life of 28 years. The chelating agent is expected to work equally well on either form of the element.

Dr. Kroll warned that the results of the present research had no immediate practical application "since the amount of chelating agent required to produce an increased urinary excretion of radio-strontium is some five to ten times greater than the maximum dose that can be administered to humans."

However, the results of this work have contributed to our knowledge of the chemistry of chelating agents and how they may be used in promoting radiostrontium excretion. Current research at the hospital is aimed at synthesizing and testing new compounds which may be more effective in radioelement decontamination.

Strontium is an alkaline-earth metal so similar to calcium in biological and chemical properties that it has an affinity for bone tissue. If the strontium

is radioactive it may produce irreparable damage to tissues and fluids.

The similarities between strontium and calcium made it necessary to examine a large number of chelating agents to find compounds with a particular affinity for strontium. The removal of extremely minute amounts of radiostrontium from a living environment containing very high amounts of calcium is a difficult problem.

When a small amount of radiostrontium is administered to a rat or mouse, it moves rapidly into the fluids and soft tissues of the body and then is incorporated into the bones.

After one hour, only a very small percentage of the administered radiostrontium can be detected in the blood, and radioautograms reveal that most of the radioactivity is localized in bone tissue. To provide the optimum conditions for evaluating the chelating agent, the radiostrontium and the organic compound were injected intraperitoneally (into the abdominal cavity) in rapid sequence.

The promotion of the radiostrontium excretion by the chelating agent falls off rapidly as the time interval between exposure and treatment increases.

The effective compound, BAETA, has the chemical name bis dicarboxymethyl aminoethyl ether.

The chelates (key-lates) get their name from the Greek word "chele," meaning claw. The large pincers of lobsters are called chelae. The chemical chelates are aptly named because their clawlike structures can snare metal atoms and help eliminate them from the body.

Dr. Kroll's co-authors were Maria Gordon and Elsie Segal, also of Montefiore Hospital.

Another paper, delivered by Albert E. Sobel, head of the department of biochemistry at The Jewish Hospital of Brooklyn, reported that strontium atoms will not act as centers for new bone cells. Shortly after being taken into the body, he said, strontium be-

comes part of bone crystal through deposition on the already formed calcium phosphate nuclei.

He inferred from this that "it should be possible to remove strontium lodged in the bone in the period immediately after its deposition."

Later, the surface strontium, which moves to the interior of the crystal, becomes more difficult to remove.

Fuel Research

Toy Furnace Grades Oil

➤ A STANDARD method of grading fuel oil for home burners has been developed through the use of a "toy" furnace.

Cleaner, more efficient fuel and information leading to improved burner design are other promises of the new "Micro Test Burner," a scaled-down version of the common heating unit, reported by R. A. Billmeier and C. Liddy, chemists at the Socony Mobil Oil Company, Brooklyn, N. Y. The prototype already has made it possible to work out a test for combustion index, and this index gives an indication of the amount of smoke that will be produced in full-scale equipment, he said.

Smoke is an expensive impairment of burning efficiency. Although standards have been established which classify oils as to grade of refinement and suitability for various types of burners, no practical combustion test is available to measure the smoking tendency of a household fuel.

The expected yardstick for measuring combustion quality, analogous to the octane rating for gasoline, would lead to continual improvements of

fuel oils and perhaps a way of predicting in advance the performance of fuels in a particular type of burner.

Unlike a full-scale burner, the miniature furnace is capable of very fine adjustment and clearly differentiates between performance related to fuel composition and that related to equipment design.

The pint-size burner uses only 1 per cent as much oil as the home type burner, and its combustion chamber is only 1½ inches wide and 9 inches long. Oil is fed into a specially designed nozzle with a high precision displacement pump. An air stream under slight pressure meets the oil within the nozzle, resulting in an atomization similar to that occurring in conventional equipment.

Check on Fuel Cheats

➤ IT TAKES an auto-racing chemist to catch a cheating race driver.

K. D. Roettger, a chemistry instructor at Worcester Polytechnic Institute and former professional racing driver, told the story of how he catches cheaters who secretly soup up their cars for auto races. He demonstrated a portable kit which comes complete with chemicals, test tubes, and instruc-

tions, and produces color changes if exotic fuel components are present in gasoline, red for methyl alcohol, reddish-brown for nitro compounds, and tan for ether.

Such super-fuels are not only unfair to honest competitors, but also are beyond reach financially for most amateur racing drivers, Mr. Roettger observed. Besides, they are dangerously toxic, inflammable, and explosive.

Amateur sports car racing and drag racing have become very popular weekend sports and, as they have grown, rules have been formulated to govern them and to maintain sportsmanship.

One of the more recent rules restricts the cars to gasoline for fuel. This rule is sensible for safety and for economic reasons.

But nearly every organization has a few individuals who regard the 'gasoline only rule' as an open invitation to cheat. Using gasoline bases, they add appreciable percentages of the banned ingredients and improve their machines' performance without detection.

Realizing that this cheating was occurring, the New England Timing Association appealed to Mr. Roettger as a chemist to develop a series of tests to detect culprits.

The first step was to make a list of chemicals that are most used for what the mechanics call 'chemical supercharging.' First on the list is methyl alcohol. With its cool, clean burning and an octane rating above 400, 'alky' has long been a favorite racing fuel.

A second important fuel type is the nitro class, including nitromethane

and nitrobenzene. Third is ether, which is used less but has been part of many secret fuels. Other additives are of lesser importance, since they are not added for their fuel value, but simply as blending agents and gasoline cleaners. Their use is also limited by their very obvious odors.

Thus, the problem was merely to find easy qualitative tests for three types of organic compounds — alcohols, nitros and ethers.

The ceric nitrate test is used to detect alcohols after a water extraction. Nitro compounds are revealed by the ferrous hydroxide test. Iodine in carbon disulfide reveals the presence of ethers. Other additives are of little importance. Packaged in a portable kit, with directions, the tests can be used in the field by non-technical personnel.

Gasoline Knock Agents

► KNOCK AND NO-KNOCK components of gasoline can now be separated according to the differences in the size of their molecules, by a new process that is more economical than the conventional separation by distillation.

The slender "straight-chain" molecules that cause knocking in an automotive engine can be adsorbed by a special kind of crystal, while the larger, knobby-shaped molecules of "iso and cyclic hydrocarbons" are excluded and emerge as high octane gasoline, Dr. G. J. Griesmer of the Linde Company, Tonawanda, N. Y., reported.

The separation is accomplished by forcing "light naphtha" from petroleum through a bed of pellets made of hydrous silicate crystals. This kind

of adsorbing material is called a "molecular sieve." The principle has found use in several industrial processes.

Molecular Sieve Type 5A crystals, the type used in the new application, will accept only those molecules having a critical dimension less than about 20 billionths of an inch. For this reason they are highly selective for the straight-chain molecules that petroleum refiners wish to eliminate from gasoline.

The molecular sieve vacuum process as applied to pentane-hexane upgrading is unique in its ability to make a product which is substantially free of normal paraffins (compounds with straight-chain molecules). With such a process it is possible to make a product of higher octane quality than is economically practicable with fractionation.

Although the use of molecular sieves will become more and more advantageous as the required octane level for super-premium motor fuels increases, the vacuum process cost already appears attractive. In addition, it is possible to apply other molecular sieve separation cycles to octane improvement processing.

H. B. Rhodes and K. Kiyonaga, also of the Linde Company, were co-authors of the report.

Unequal Fuel Distribution

➤ EACH CYLINDER in your car may be getting a different amount and a different kind of fuel, Dr. D. E. Cooper of the Ethyl Corporation, Detroit, told the chemists.

Because the various components of gasoline and antiknock additives evaporate

at different rates, all the cylinders of an automobile engine may not receive their full share of effective fuel. The resulting knock may force the motorist to buy a higher octane gasoline to correct a problem occurring in only one or two cylinders.

Fuel savings, better engine performance and lower octane requirements are expected to result from Dr. Cooper's analysis of fuel fed to each cylinder of an engine.

Tagging one compound in a motor fuel with tritium, a radioactive form of hydrogen, has enabled chemists in the Ethyl laboratories to trace the amount of that compound that goes through each separate cylinder. The process can be repeated with other gasoline and antiknock compounds in the fuel.

The research has revealed that the compounds in a given gasoline that boil at the lowest temperatures, and those that boil highest, are not distributed evenly among the cylinders. One component, normal octadecane, was found to deviate by as much as 27% in one cylinder from its content in the original fuel. The compounds that boil at intermediate temperatures distribute themselves quite evenly.

Methods of attacking the problem may include tailoring the fuel so that high octane compounds of both high and low-boiling range are present, and changes in the design of carburetors and manifolds also may be desirable, Dr. Cooper said.

The intake system of the typical automobile engine rarely delivers equal quantities, or qualities, of gasoline to all the cylinders. This situation often limits both performance and

durability. It is important to be able to measure these differences so that improvements resulting from changes in design can be recognized. The resulting correlations can then point the way to further improvements.

Unequal quantities of fuel in the cylinders means that some are over-rich and some are over-lean. Either condition tends to reduce power, and the over-rich condition is wasteful. This maldistribution is caused mainly by the liquid part of the feed. All the gasoline is not vaporized, and the residual portion flowing along the inner walls of the manifold does not enter all the branches equally. It is possible to measure the resulting richness or leanness of cylinders by analyzing samples of the combustion gases from each cylinder.

Studies of this kind have revealed how either very low or very high

volatility will cause a fuel component to disproportionate with respect to the rest of the fuel. After these relationships have been fully mapped for an engine condition it becomes possible to predict the distribution under similar conditions of untested substances such as new additives.

Furthermore, many other aspects of fuel behavior can be clarified by an understanding of distribution characteristics. Among these are antiknock performance, differences in the amount and the kind of deposits found in cylinders, and engine power output or economy.

The gains in performance and economy provided by improved carburetor designs have been demonstrated. Perhaps of even greater practical importance, we now have a means of detecting and measuring such improvements when we achieve them.

Food Chemistry

Flavor Enzymes Improve String Beans

► SCIENTIFIC advances in the study of string beans now suggest possible ways of achieving a commercially feasible method of enhancing the true flavor of frozen and dehydrated green beans, according to Dr. Winifred M. Cort, Research Project Leader at Evans Research and Development Corporation, New York.

In previous research, it had been shown that true natural flavor could be enhanced in processed foods by proper utilization of flavor enzymes, unique biochemical catalysts that occur in the foods in their natural state. The present research report is an ex-

tensive study of the specific enzyme systems involved in the development of string bean flavor.

In evaluating and analyzing the results, sensory panel observations were paralleled by highly advanced ionization detector gas chromatography, and mass spectroscopy.

The results of the work point out the possibility of utilizing waste plant material as a possible commercially useful enzyme source for the flavor restoring process.

Associated with Dr. Cort in this research were Dr. Eric J. Hewitt of Evans Research, Dr. S. David Bailey and Miss Alice McCarthy of the

Quartermaster Research and Engineering Command.

Protein Supplemented Foods

► THE PROBLEMS of labeling foods supplemented with proteins were discussed by Dr. Leo Friedman of the U. S. Food and Drug Administration's Division of Nutrition.

"As a result of the improved food technology in this country, a large portion of our food supply is commercially processed," he told the chemists. "This has made possible improvements in nutritive value of foods by supplementation with nutrients that are of significance to the consumer. In some instances the availability of supplements has led to their commercial exploitation when no demonstrable benefit to consumers could be observed.

"A product becomes a food for special dietary use because of the representations made for its nutritive value but under the Food, Drug, and Cosmetic Act, such food must be labeled fully to inform the purchasers of its value for the proposed use."

Protein Index for Foods

► A PROTEIN INDEX that can be assigned to a food product and shown on its label, an animal-feeding procedure for establishing such an index, and a chemical test for the rapid preliminary checking of foods were described by Dr. J. A. Campbell, chief of the vitamin and nutrition section of the Canadian Food and Drug Directorate.

"Under this system foods such as meat, milk, eggs and fish, with a protein rating of 40 or more could be

called 'excellent dietary sources of protein,'" the speaker said. "No claims would be made for foods such as vegetables and cereals with ratings below 20, because they do not furnish significant contributions of protein in both quantity and quality.

"Foods with ratings of 20 to 40 lie in an intermediate position and might be designated as 'good dietary sources of protein.' This category is one that can be reached by significant improvements in quality or quantity of protein in foods for which claims would not normally be permitted. The procedure has been applied to a variety of foods and appears to classify them in a logical manner."

Claims are made for foods that are recognized as good sources of protein, but also for those that are not, Dr. Campbell asserted. The proposed protein rating method is an attempt to place claims on a sounder basis.

"There has been general acceptance of the term 'high quality' to describe proteins of animal origin such as meat, eggs and milk," the chemist pointed out. "While cereal proteins, on the other hand, are of relatively poorer quality, there has been considerable interest in their improvement. Such improvement is laudable, but it would seem undesirable to apply the terms 'high quality' or 'excellent dietary source' to any foods which were not equivalent to milk, meat or eggs in both quality and quantity of protein.

"Under the proposal these terms would have definite meanings that should be equally useful to the manufacturer and consumer."

A rat-growth assay for determining the protein efficiency ratio of a food when fed in an otherwise complete diet was described by Dr. Campbell, who emphasized the importance of standardizing the animals and procedures used by different laboratories.

A "simplified chemical score" can be obtained rapidly by measuring the content in a food of three building blocks of protein — lysine, methionine and cystine, it was stated. Since most common foods are deficient in these amino acids, such a technique is quite reliable, and is considered to be useful for those laboratories which may not have facilities for animal assay, the chemist indicated.

"For regulatory purposes, it is important to know the value of individual foods and to realize that this value may change when the food is consumed as part of a mixed diet," said Dr. Campbell. "Concerning claims for the protein content of a food, it is felt that they must be on the basis that, for the average individual, the food contributes a significant proportion of the total protein requirement when consumed in a usual or reasonable manner.

"In the case of protein, three factors appear to be involved: the amount of food in a reasonable daily intake, the percent protein of the food, and the biological value of the protein. Since protein requirements may be satisfied by varying amounts of protein, depending on its biological value, a protein rating was developed which was the product of protein efficiency ratios of a food and the grams of protein in a reasonable intake. Reasonable in-

take is usually considered to be one serving, but may be more in the case of such foods as milk and bread.

"Suggestions have been made that, because of the supplementary action of amino acids, the classification of proteins individually is of relatively little significance in assessing the protein value of diets. It was felt, nevertheless, that for regulatory purposes it was important to know the value of individual foods, but to realize, also, that this value may change when the food is consumed as part of a mixed diet."

Heat Effect on Protein

➤ THE EFFECT of heat on three of the essential components of meat protein was described by Dr. C. H. Lushbough of the American Meat Institute Foundation, Chicago, Ill. Reduction in quality seems to depend upon the extent and severity of the heat treatment which at higher temperatures reduces available amounts of the amino acids, lysine, methionine and tryptophan, he said.

"In meats roasted to 60° Centigrade, small but not significant reductions of the amino acids were observed as compared with fresh, uncooked meat samples," it was reported. "Further small but not significant decreases occurred in meats roasted to 80° C."

When meat was cooked in a vessel similar to a pressure cooker for 4 to 16 hours at 120 degrees Centigrade, there were "large and significant" decreases in availability of the amino acids.

Agricultural Chemistry

Moth "Perfume" Effective

► THE CHARM of the female gypsy moth, when simulated by chemists, is literally fatal to the male insect.

A synthetic female moth scent which lures the males into traps is one of three new chemical baits reported by U. S. Department of Agriculture chemists. Also described were medlure, an improved compound to trap the Mediterranean fruit fly, and an attractant for the melon fly. In addition to protecting the nation's forests and crops, such agents are expected to be useful at ports of entry in detecting pests harbored in produce from abroad.

The chemical baits, placed in containers resembling tin cans with both ends open, simulate odors and other airborne stimuli which normally guide insects to such basic needs as food, host plants and mates. Once in the trap, the bugs may be killed if desired, by insecticides used in combination with the lures. Without the added lethal chemicals, attractants measure degrees of infestation.

Of a number of compounds field-tested during the past three summers, the most effective gypsy moth "perfume" is a substance known chemically as 1,2-hexadecanediol, reported Martin Jacobson, chemist of the Department of Agriculture's entomology research division, Beltsville, Md. This agent, which proved its attractiveness this year in trials in New Hampshire, Spain, and Morocco, has been patented.

The gypsy moth is a costly menace

to forest and shade trees especially in the New England and eastern New York areas. Normally, traps used for moth control are baited with segments of the female moths, but the difficulty of obtaining the natural substance led to the search for a chemical substitute.

On the basis of trials with nearly 2,000 chemical compounds in 1957 and 1958, a number of agents known as diols were tested this year. Some of these were promising in preliminary work but failed to lure moths in subsequent research, Mr. Jacobson said, adding:

"Another compound, 1,2-hexadecanediol, was found to be as active as the natural standard in laboratory tests and was attractive to moths in field tests."

The development of other insect lures was described by Dr. Morton Beroza, a second speaker on the program. According to Dr. Beroza, who is head of the synthesis section in pesticide research, the new Mediterranean fruit fly lure, medlure, was made by adding hydrochloric acid to seglure, an earlier bait. Seglure recently had an important role in the eradication of the "Medfly" from 800,000 acres in Florida.

Medlure is at least twice as attractive as seglure and lasts five times as long in field trials. It is therefore a greatly improved product.

Latest research, still in progress, indicates that a medlure derivative may be superior to the original compound.

In seeking a melon fly lure, the De-

partment of Agriculture researchers found two years ago that a compound named anisylacetone was effective but did not attract the insects until they were 10 to 12 days old.

The search for better melon fly lures has continued and recently several that are superior to anisylacetone have been found. The best of these is 4-(p-acetoxyphehyl)-2 butanone. The new compounds attract even newly-emerged flies.

Such lures can be used in traps to find new infestations; in effect the insect betrays his presence by responding to the lure. The lure can be used to guide the application of control measures so that these need be applied only where and when needed. In this manner considerable economies may be effected and needless broadcasting of toxic material is avoided. If the goal is eradication (and this goal is being considered more and more seriously for many insect species these days) then a lure will be invaluable in finding the last few insects and thus making sure the job is complete.

These lures are becoming increasingly important. With fast intercontinental trade and traffic expanding rapidly the U. S. Department of Agriculture must maintain a constant vigil to prevent the introduction of insect pests that could do serious damage to agricultural resources.

Other Department of Agriculture chemists who collaborated in this research and the preparation of the reports were Nathan Green and S. I. Gertler.

Spruces "Aromatize" d-Glucose

➤ AMONG THE important reactions under widespread investigation in con-

temporary biochemistry are the reactions associated with a phenomenon called "aromatization." Aromatization is concerned with the fermentation of a specialized ring structure of six carbon atoms, called a "benzene ring." Two examples of this aromatization process are at present under investigation in the laboratories of Dr. F. F. Nord at Fordham University. The first of these is called "lignification," which is the hardening process which occurs in all woody plants. It is the result of the deposition between the cells of woody plants of an "aromatic" compound called "lignin." But a fundamental question is: What is the source of this lignin? Where does it come from?

It has long been known that the fundamental biosynthetic reaction occurring in living plants is the process of photosynthesis whereby water and the carbon dioxide of the atmosphere are converted by the plant into oxygen and carbohydrates. But the organic compounds formed in photosynthesis, i.e., the carbohydrates, have very little chemical structure in common with the aromatic compound, lignin. How then is this lignin formed?

After feeding Norwegian spruce trees with aqueous solutions containing radioactively labeled glucose, which is a relatively simple carbohydrate product of photosynthesis, Dr. Nord and his colleagues at Fordham, Dr. W. J. Schubert and Mr. S. N. Acerbo, have isolated the lignin formed from these trees, and have found in it the radioactivity originally present in the glucose. This proves then that these trees have the ability to convert the carbohydrate, glucose, into the aro-

matic compound, lignin. Furthermore, by studying exactly where the radioactivity is located in the lignin molecules, these investigators have proven that the glucose molecules were not broken down into small fragments before being converted into lignin, but rather, they were used as intact units. This indicates then that in trees, the glucose formed photosynthetically is a precursor or progenitor of the lignin.

The second aromatization process under investigation is concerned with the metabolism of an aromatic organic ester, methyl p-methoxy-cinnamate by a wood-destroying fungus *Lentinus lepideus*. A study of the metabolism of this compound by the fungus involves two distinct phases:

(a) Its formation by the fungus from glucose. Since the ester like lignin is another example of an aromatic compound, while glucose is not aromatic, this process, like the lignification referred to above, is another example of "aromatization."

(b) The second aspect of this metabolism is concerned with the eventual consumption of this ester by the fungus which had originally formed it. This is known to occur because, in its early stages of growth, while *Lentinus lepideus* is still synthesizing this ester, the compound accumulates in the culture medium as a crystalline deposit. But in the later stages of growth, these crystals gradually disappear, indicating that the organism must be subjecting the compound to further chemical modification.

In their most recent investigations, Drs. Nord and Shimazono have found that two distinct processes, namely demethylation and hydroxylation, are instrumental in the degradation of the aromatic ester by the fungus. Demethylation and hydroxylation are no longer novel reactions in biochemistry, but it is believed that this is the first time these two reactions have been demonstrated to occur as a result of the action of fungi on such aromatic esters.

Other Papers

Suppress Free Radicals To Fight Fire

➤ THE OLD CONCEPT, that a fire can be extinguished by removing the fuel, the heat, or the oxygen, must now be modernized to include a fourth element.

The new factor is "the chain reaction of free radicals" in a flame, essential to the existence of fire, according to Arthur B. Guise of the Ansul Chemical Company, Marinette, Wis. Recent research on this reaction may lead to a better understanding of how

fire extinguishing agents work and to more effective provision for fire fighting.

Free radicals are short-lived, chemically active fragments of molecules. At the high temperatures in a flame they regenerate themselves by a chain-reacting process and so keep the flame going.

At the beginning of the research program, aimed at evaluating the extinguishing effectiveness of carbon tetrachloride, chlorobromomethane, methyl bromide and other compounds

of the "halogenated hydrocarbon" class, it was thought that the extinguishing action was due to cooling by evaporation and smothering by the vapors. It is now believed that the major extinguishing mechanism is a chemical chain-breaking action.

New compounds of the same type were studied, and one, bromotrifluoromethane or Halon 1301, is now under consideration for military applications. It has excellent extinguishing power and low toxicity, but its cost, \$4 a pound, has delayed widespread commercial use.

Dry chemicals used to put out fires are believed to operate primarily by interrupting the chemical chain-reaction. Cooling and dilution of the fuel and oxygen are relatively minor factors. Even chemicals such as salt, which are not readily decomposed by heat, are effective extinguishing agents when applied as a powder.

Where streams from extinguishers are used, the physical characteristics of the halogenated compounds may impose limitations that do not allow the theoretical effectiveness of the extinguishing agent to be obtained.

Our past concept of fire and fire extinguishment must be modernized in the light of recent findings. Actual chemical action to interrupt the flame chain-reaction must be added to fuel, heat, or oxygen removal as a basic mechanism of extinguishment. Within the framework of this new concept, four primary types of extinguishing agents function effectively in various ways. Water in various forms extinguishes by cooling or smothering. Carbon dioxide dilutes the reactants

or excludes oxygen. Halogenated hydrocarbons combine these actions and also introduce chain-breaking capability. Dry chemical apparently functions almost exclusively by interrupting the flame chain-reaction.

New Gauge for Pollution Damage

► POTENTIAL DAMAGE to sea life by industrial wastes has been measured with the wrong gauge for the past forty years.

The standard technique for measuring possible poisonous effects of industrial pollutants considers only fish as test organisms even though other organisms are more sensitive to such wastes and more fundamental to the over-all economy of the sea, Dr. Donald W. Hood, Thomas W. Duke, and Bernadette Stevenson of the Agricultural and Mechanical College of Texas, reported. These other organisms are, in fact, the food that the fish live on.

Hazards to fish and other marine organisms are of increasing concern because of the growing use of the sea for waste disposal.

The "toxicity to fish technique" was developed in 1918 and is still in common use. It is the standard procedure recommended by the Committee on Research of the Federation of Sewage and Industrial Waste Associations.

Since aquatic organisms such as shrimp, algae and diatoms play the same role in the ocean as grass and grain crops do on land, they are really the most important community with respect to the over-all economy of the sea. It seemed logical to the scientists that the reactions of such organisms

might make better criteria than those of fish for judging the toxicity of industrial waste materials.

A water sample from a polluted stream known to contain sulfur and chlorinated organic wastes was run through the standard test in a research project. A type of fish called *Cyprinodon variegatus*, common to Texas bay areas, showed no adverse effects after four days.

To compare the reactions of other marine organisms, the same test was made with grass shrimp found in coastal waters, brine shrimp hatched from eggs bought in a pet shop, and phytoplankton consisting of green and red algae and diatoms. The phytoplankton are probably the most important group for the purposes of this test.

During the four-day test period 30 per cent of the grass shrimps were killed, and the life process (photosynthesis) of 50 per cent of the plankton was stopped within one day.

These data indicated to the researchers that more attention must be paid to the more fundamental organisms of the marine community, and perhaps the freshwater community, in

order to determine the true effect of effluents on the over-all economy.

The toxicity of organic wastes to aquatic organisms has been a subject of considerable study by many organizations through the past years. This aspect of pollution in the marine environment has gained impetus only recently, largely due to increased use of the sea for waste disposal and interest in coastal fisheries, both from the sportsmen's and commercial fishermen's point of view.

In order to compare biological assay data obtained with fish with that obtained on other organisms, a water-soluble waste containing some chlorinated organic materials and other alkaline waste products from sulfur-containing streams, and also water-insoluble material consisting largely of chlorinated hydrocarbons, were used as the toxic materials. In these experiments the inhibition of photosynthetic activity of the plants caused by the waste material was used as a criterion of toxicity.

Comparison of these organisms showed that the sensitivity to the waste material investigated increases as we go from the fish, to shrimps, to phytoplankton.

Airborne Determination of "G"

➤ WITH AN airborne gravity meter, man will be able to measure the face of the earth accurately "for the first time," according to Fairchild Aerial Surveys, Inc., Los Angeles, California, LaCoste-Romberg Co. of Austin, Texas, and Gravity Meter Exploration Co. of Houston, Texas. A recent test indicated that it is now possible to meas-

ure gravity in the air any place in the world to an accuracy adequate for geodetic purposes, they reported. With the device, cartographers can draw more accurate maps, scientists can calculate orbits of missiles to a greater degree of accuracy and geologists will have a new aid in the search for oil, the companies said.

Acid-Base Indicators from Flowers

by JEFFREY A. GREENHOUSE, *Uniondale H. S., Uniondale, N. Y.*
Jeffrey Greenhouse, 16, was a winner in the 18th Science Talent Search. He hopes to make a career in chemical research, and is studying chemistry at Syracuse University.

➤ ACID-BASE INDICATORS are highly-colored organic dyes which exhibit changes in color when the acidity or alkalinity of a solution is changed between certain limits. These limits constitute the pH range and vary for different indicators. pH is a measurement of the acidity or alkalinity of a solution equal to the negative logarithm of the hydrogen-ion concentration. These values range from 0 to 14. A pH of 0 is highly acidic, a pH of 7 is neutral, and a pH of 14 is highly basic.

Various high-school chemistry text books mention that some flowers contain acid-base indicators. Nothing was found in the literature describing the color changes, pH range, or other properties of these indicators. This suggested the need for an investigation of these substances. This report presents the methods and results of this investigation.

Methods

Extraction of Indicators

The indicators were extracted from the flowers by boiling the petals in distilled water until the color was removed. This solution was then filtered to remove any solid particles. The average flower yielded 15 to 20 ml of solution.

Preliminary Testing

A preliminary test was carried out on each solution to determine whether

or not it was an indicator and, if so, what the color changes were. This was simply done by adding a few drops of indicator solution to a small amount of hydrochloric acid (HCl) and sodium hydroxide (NaOH) and observing the color change in each case.

Titration

To determine the pH ranges, the standard procedure for titration was adapted to suit the conditions of the experiment. Instead of using a known solution of acid or base, a known indicator and an unknown solution of base or acid, known solutions of both acid and base and an unknown indicator were used.

At first 0.1 M solutions of HCl and NaOH were prepared and used. This led to certain inaccuracies which will be mentioned later. They were corrected by the use of 0.01 M solutions.

The pH range was determined in two steps:

1. Twenty ml of HCl were introduced into a beaker.
2. The indicator was added until the intensity was great enough so that any future color change would be apparent.
3. This solution was titrated with NaOH until the color began to change.
4. The amount of NaOH added was measured.

5. The pH of the solution was determined mathematically.

This value gave the acid end of the pH range. By reversing the solutions the other limit was found.

Difficulties and Sources of Error

The indicator solutions presented a few problems. A sediment invariably began to form in all of the solutions after they had been standing for about two days. This was annoying, but in no way affected the color changes of the indicators.

The extracts from the flowers also contained a nutrient which supported the growth of mold. This growth was prevented by keeping the solutions in sealed bottles.

On standing for a few months, the extracts lost their indicator properties and the color changes became less distinct, necessitating the preparation of fresh solutions. This limited the number of experimental flowers available.

The 0.1 M solutions of HCl and NaOH originally used in the titrations were found to be too strong, preventing a sufficiently delicate titration. The 0.01 M solutions corrected this difficulty.

The exact point at which the color change took place was difficult to observe for one of two reasons:

(1) A few of the indicator solutions were very dilute and the colors in the HCl and NaOH were extremely pale; a color change could not readily be seen.

(2) The actual colors of the indicator solutions were shown not to be the acid-base indicators; their presence interfered with the true color changes.

Because the exact point at which the color began to change could not be found, the pH ranges probably dif-

fer from the true limits by a slight amount (less than one unit). This was the greatest source of error in the experiments.

The concentrations of the original HCl and NaOH solutions were not exactly 0.1 M. This was due to inaccuracies in measurements during their preparation. Therefore the mathematical determinations did not yield the true pH ranges. When use of the 0.01 M solutions was begun, all further measurements of pH were made with a pH meter. This eliminated any inaccuracy in the molarity of the reagents used.

Results

Thirty-two flowers were given the preliminary test described above and all were found to be indicators. The observations are recorded in the Table. It can be seen that the colors of the extracts are generally the colors of the flowers from which they are extracted. Yet the color changes are all either red to yellow or colorless to yellow. This suggested that the indicators tested are all the same and are not dependent on the color of the flower.

Eight indicators were tested using the 0.1 M reagents. The results are recorded in the second column of the Table. They all show similar pH ranges. None of the ranges is more than one unit, while the normal range of an indicator is about two units. This suggested an inaccuracy in these results.

The results of the tests using a pH meter are listed in the first column of the Table. The ranges shown are for twenty indicators and are, in most cases, very similar. The large differences are due to interference from the color of the flower or the low con-

TABLE I
RESULTS OF PRELIMINARY TESTS

Flower	Color of Extract	Acid Reaction	Basic Reaction	pH Range*	
Red salvia	pink	orange	yellow	2.65 - 5.55	
Blue petunia	violet	red	yellow-green	3.05 - 5.75	
Yellow zinnia	pale yellow	colorless	yellow	3.20 - 5.30	
Red zinnia	pink	red	yellow	2.80 - 6.10	
Rose of Sharon	red-violet	red	yellow	2.50 - 5.20	
Yellow marigold	yellow	colorless	yellow		
Tea rose	clear	pink	yellow		
White zinnia	yellow	colorless	yellow		
Pink aster	pink	pink	yellow		
Yellow chrysanthemum	yellow	colorless	yellow	4.25 - 6.45	
Red carnation	deep red	pink	yellow-green	3.00 - 6.40	2.60 - 3.00
Red rose	light red	pink	yellow	2.85 - 5.00	2.30 - 2.70
White daisy	clear	colorless	yellow		2.80 - 3.30
Red chrysanthemum	dark red	red	yellow	2.80 - 6.50	2.50 - 3.30
White chrysanthemum	yellow	colorless	yellow	5.45 - 6.15	2.80 - 3.60
Pink daisy	pink	pink	yellow		2.60 - 3.60
Pink chrysanthemum	cloudy	pink	yellow		
Pink carnation	yellow	pink	yellow	2.75 - 6.50	2.10 - 2.90
Blue celery	blue	red	yellow		2.55 - 2.90
Red celery	red	red	yellow		
White geranium	yellow	colorless	orange-yellow		
Forsythia	yellow	colorless	yellow		
Purple azalea	yellow	colorless	yellow		
Hydrangia	clear	pink	yellow	2.75 - 5.20	
Phlox	yellow	pink	yellow	3.00 - 6.70	
Purple zinnia	red-brown	red	yellow	2.50 - 5.80	
Yellow gladiola	yellow	colorless	yellow	4.30 - 5.85	
Red azalea	pink	pink	yellow	3.00 - 8.50	
Red & White azalea	pink	pink	yellow	2.80 - 8.20	
Impatiens	pink	pink	yellow	2.80 - 6.30	
Orchid	purple	pink	yellow	3.40 - 7.40	
Scabiosa	yellow	colorless	yellow	2.90 - 6.10	

* The first column of pH ranges was determined with a pH meter, while the second column was calculated mathematically.

centration of some of the extracts. The small differences are due to the previously-described difficulty in observing the exact point at which the color began to change.

Conclusions

All of the flowers tested contain the same substance, which acts as an acid-base indicator. This indicator is red when the pH of the solution is less

than 2.8 and is yellow when the pH is greater than 6.0. Between these values it becomes colorless.

Suggestions for Further Experiments

Separation of the indicator from the extraneous coloring matter will be attempted. Alcohol will be used to extract the indicator. This is the next step in the project. The alcohol will

serve the additional purpose of preventing the growth of mold.

Another line of experimentation involves making extracts which do not form sediment on standing. According to Kolthoff, "Various plants contain natural dyes which resemble acid-base indicators. Actually such extracts have little practical value because the dyes as a rule are very impure and their alkaline forms usually undergo decomposition."

Although this may be true, some work might develop a usable indicator.

Sample Mathematical Determination of pH

20.2 ml of 0.1 M HCl were added to 20.0 ml of 0.1 M NaOH. The NaOH was all neutralized leaving in excess 0.2 ml of 0.1 M HCl in 40.2 ml of solution. Therefore,

$$\text{Hydrogen-ion concentration} = \frac{(0.2)(0.1)}{40.2} = .0005 \text{ M} = 5.0 \times 10^{-4}$$

$$\text{pH} = -\log (5.0 \times 10^{-4}) = -(.70-4) = 3.30$$

✓ Chemistry Quiz ✓

Directions: Mark the answer you think is most nearly correct.

Answers are on page 43.

- | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|-----------------|-------------|------------|-----------|----------------------|--|---------------------|--|-------------------|--|-----------------------|--|-------------|------------|-----------|-------------|--|---------------|-----------------|-------------|--------------|----------|-------------|-----------|-----------|
| <p>A. Which of the following elements has been shown to be useful in measuring the antiquity of bones?</p> <table border="0" style="width: 100%;"> <tr> <td>1. argon</td> <td>3. fluorine</td> </tr> <tr> <td>2. calcium</td> <td>4. sulfur</td> </tr> </table> <p>B. Which of the following is a water softener?</p> <table border="0" style="width: 100%;"> <tr> <td>1. calcium carbonate</td> <td></td> </tr> <tr> <td>2. hydrogen sulfate</td> <td></td> </tr> <tr> <td>3. sodium sulfate</td> <td></td> </tr> <tr> <td>4. sodium tetraborate</td> <td></td> </tr> </table> <p>C. Which element below seems to be the <i>most</i> useful in making transistors?</p> <table border="0" style="width: 100%;"> <tr> <td>1. antimony</td> <td>3. silicon</td> </tr> <tr> <td>2. carbon</td> <td>4. titanium</td> </tr> </table> | 1. argon | 3. fluorine | 2. calcium | 4. sulfur | 1. calcium carbonate | | 2. hydrogen sulfate | | 3. sodium sulfate | | 4. sodium tetraborate | | 1. antimony | 3. silicon | 2. carbon | 4. titanium | <p>D. Which of the following does <i>not</i> belong to the "rare earth" family?</p> <table border="0" style="width: 100%;"> <tr> <td>1. androecium</td> <td>3. praseodymium</td> </tr> <tr> <td>2. lutetium</td> <td>4. ytterbium</td> </tr> </table> <p>E. From which of the following substances is C₁₄, radioactive carbon, made?</p> <table border="0" style="width: 100%;"> <tr> <td>1. boron</td> <td>3. nitrogen</td> </tr> <tr> <td>2. carbon</td> <td>4. oxygen</td> </tr> </table> <p><i>Complete copies (with answers and norms) of many previous Science Talent Search examinations are available at 15c each from Science Service, 1719 N St., N.W., Washington 6, D. C.</i></p> | 1. androecium | 3. praseodymium | 2. lutetium | 4. ytterbium | 1. boron | 3. nitrogen | 2. carbon | 4. oxygen |
| 1. argon | 3. fluorine | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. calcium | 4. sulfur | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. calcium carbonate | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. hydrogen sulfate | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3. sodium sulfate | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4. sodium tetraborate | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. antimony | 3. silicon | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. carbon | 4. titanium | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. androecium | 3. praseodymium | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. lutetium | 4. ytterbium | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. boron | 3. nitrogen | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. carbon | 4. oxygen | | | | | | | | | | | | | | | | | | | | | | | | |

BIBLIOGRAPHY

- Deming, Horace G., *General Chemistry*. John Wiley & Sons, 1944, pp. 249-50, pp. 258-9.
- Kolthoff, I. M., *Acid-Base Indicators*. Macmillan, 1953.
- McPherson, W., Henderson, W., and Fowler, G., *Chemistry at Work*. Ginn and Company, 1955, pp. 243-44.
- Pierce, Willis C., and Haenisch, Edward L., *Quantitative Analysis*. John Wiley & Sons, 1948, pp. 152-70.

Antithetic Oxides of Carbon

by BURTON L. HAWK

2. CARBON DIOXIDE

➤ HAVING DEALT with the less desirable member of the family (see Carbon Monoxide: CHEMISTRY, Sept., 1959), we can now relax as we consider carbon dioxide. For carbon dioxide is a pleasure to experiment with as it is non-poisonous, non-flammable, non-explosive, and easy to manufacture. For example: to prepare CO_2 , simply exhale.

As you certainly must know, all persons or animals that breathe consume oxygen and exhale carbon dioxide. The burning of fuels also removes oxygen and adds carbon dioxide to the atmosphere. Now this would be a most distressing situation if it were not for the plants. For Nature has arranged that they should consume carbon dioxide, retaining the carbon for growing tissue, and releasing the oxygen again into the atmosphere. In addition, carbon dioxide is somewhat soluble in water and the excess dissolves in the waters of oceans, lakes and rivers. If there is ever a shortage of carbon dioxide, it is automatically released from the waters because of its partial pressure decrease (whatever that means). Hence, everything is kept nicely in balance. A superb system!

Preparation

Cover the bottom of an Erlenmeyer flask with a quantity of marble chips. Cover the chips with water and insert a two-hole stopper containing a thistle tube and an outlet tube. Be sure the end of the thistle tube is immersed

in the water in the flask. Attach a length of rubber tubing onto the outlet tube. Now you are all set to go. To generate carbon dioxide, simply pour a small quantity of hydrochloric acid through the thistle tube. It will react with the marble (calcium carbonate) releasing carbon dioxide and forming calcium chloride.

Testing

The classic test for carbon dioxide is the white precipitate formed when the gas is bubbled through limewater. Prepare limewater by dissolving as much calcium oxide in water as possible, agitating thoroughly. Filter off the excess. The clear filtrate is limewater. After adding hydrochloric acid to your generator flask, immerse the rubber tubing in a test tube of limewater and allow the gas to bubble through for a few minutes. Soon the white precipitate is formed. This precipitate is calcium carbonate. If you allow the gas to bubble through long enough, the limewater will again clarify. This is due to the formation of calcium bicarbonate, which is soluble.

Properties

As we stated above, carbon dioxide is soluble in water. Actually, it combines with the water to form carbonic acid. To demonstrate this, prepare a *dilute* solution of sodium carbonate. Add a drop or two of phenolphthalein solution to obtain the familiar pink color indicative of alkalies. Now bubble carbon dioxide through the liquid.

After a short time the pink color will gradually disappear and the solution will be colorless. This is due to the carbonic acid formed which has neutralized the alkaline sodium carbonate. Or, for another variation on the same theme, bubble the carbon dioxide through a solution of blue litmus. It will turn red.

The above reactions can also be done by exhaling. Simply blow through a glass tube through a solution of limewater. It will turn milky proving that you have exhaled carbon dioxide. The same results will be obtained with the phenolphthalein and litmus solutions . . . if you blow long enough.

Because carbon dioxide is heavier than air, you can collect it by displacement of air. Simply place your rubber tubing toward the bottom of an empty bottle. As you generate the gas it will force the air out of the bottle. You will have to guess when the bottle is filled.

If you don't like this guesswork, you may also collect the gas over water. Invert filled bottles of water in a trough and insert the rubber tubing, similar to the collection of oxygen, or as we collected carbon monoxide in the previous article. The bubbles of gas will force the water out of the bottle into the trough. Place a glass plate over the mouth of the inverted bottle and set upright on the table.

Carbon dioxide does not support combustion. Insert a burning splinter of wood in a jar of the gas. It will be extinguished immediately. Magnesium ribbon, however, will continue to burn in carbon dioxide. Insert a burning piece of the ribbon in a bottle of carbon dioxide. The continued burning is the result of a reaction; the

magnesium tears the carbon dioxide apart. The result of all this is the formation of magnesium oxide and the element carbon. Examine the jar and you will notice the white oxide and black specks of carbon.

If you have a delicate balance scale, you may demonstrate that carbon dioxide is heavier than air. Carefully balance two empty beakers on the scale. Take a bottle of carbon dioxide and "pour" the gas into one of the beakers, being careful not to touch the beaker or the scale. The beaker containing the carbon dioxide will weigh heavier. This experiment will appear mystifying as it seems that you are adding weight simply by holding an "empty" bottle over the scale.

Or, you can extinguish a candle flame by pouring carbon dioxide on top of it in a similar fashion. Again, it will appear that you are extinguishing the flame by holding an "empty" bottle above it.

You can also prepare carbon dioxide from baking powder. Place a few grams of baking powder in your generator flask. Add water through the thistle tube. Carbon dioxide is generated and can be collected as described above. As you may have deduced, the effectiveness of baking powder in raising cakes is due to the carbon dioxide liberated.

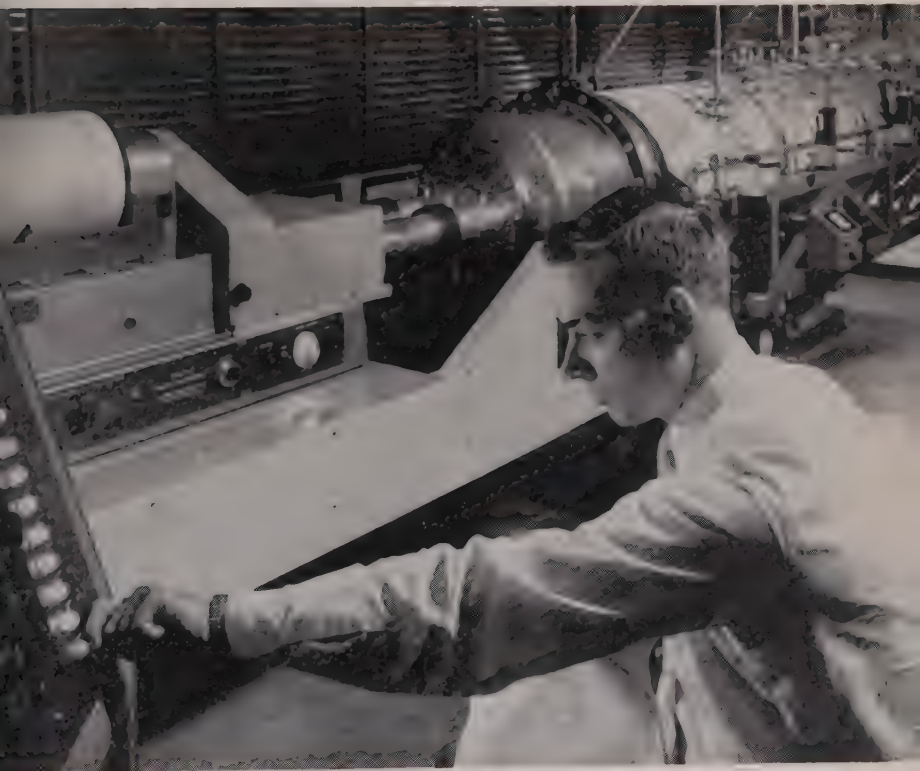
As mentioned above, carbon dioxide is released by the burning of fuel. Pour a small quantity of limewater into a jar. Ignite a splinter of wood and allow it to burn inside the jar, being careful that it does not touch the liquid. After it has burned out, cover the jar and shake vigorously. The limewater should turn milky indicating that carbon dioxide has been released as the result of burning wood.

Carbon Suboxide

A *third* oxide? Yes, carbon actually forms three oxides, the monoxide, CO, the dioxide, CO₂, and carbon *suboxide*, C₃O₂.

This compound is obtained by the dehydration of malonic acid. It is a

ketene in structure and hence it belongs to organic chemistry. It is a gas at room temperature, is poisonous, and unlike the other two oxides, it has a distinctive, unpleasant odor. It reacts with water to form malonic acid.



➤ WITH THIS long path infrared cell, assembled in Fuels & Lubricants Department of General Motors Research Laboratories, chemists hope to learn more about complicated chemistry of smog formation. Mixtures of nitrogen oxides and various hydrocarbons found in the atmosphere are irradiated with artificial sunlight in the cell (right) to determine what photochemical reactions are involved. This is part of a cooperative automotive industry study of smog.

Chemical Patents

To obtain copies of these new patents, order them by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents in coin, money order or Patent Office Coupons (but not stamps) for each patent ordered.

Reuse of Scrap Titanium

➤ **TITANIUM**, a versatile lightweight metal used increasingly in aircraft and missile construction, and zirconium, used in nuclear reactors, are two vital metals in this age of space and atomic energy. John E. McMillan of Henderson, Nev., has found an easy way to disintegrate scrap titanium and zirconium for use in making new ingots.

Metals highly resistant to heat, such as steel, molybdenum, and tungsten in addition to titanium and zirconium, are difficult and expensive to shear into bits mechanically because of their toughness, but the scraps are too valuable to let go to waste.

In his method, which he terms "economical and rapid," the scrap metal is formed into consumable electrodes which are melted onto a table electrode below by means of an electric arc. The table electrode is made to rotate so that the molten metal globules from the consumable electrode are thrown to the side where they cool.

The patent, No. 2,897,539, was assigned to Titanium Metals Corporation of America.

Coal Yields Germanium

➤ **BECAUSE** of its important role in transistors, germanium has become one of the most wanted metals of today. Cortes F. Reed of Anoka, Minn., has patented a method of ex-

tracting the grayish-white metal from alkaline coal residues.

To recover the germanium, finely divided moistened coal residues are washed with a water solution of a polysulfide compound, forming germanium compounds, to separate them from the coal residues. The germanium compounds are then acidified with hydrochloric acid and boiled to precipitate and further purify the germanium.

Mr. Reed received patent No. 2,898,188 for the invention and assigned it to Charles L. Horn of Minneapolis.

Solar-trap Window

➤ **A WINDOW** that traps solar radiation for heating or power generation has been invented by an Israeli scientist.

The inventor, Harry Z. Tabor, Jerusalem, was granted patent No. 2,888,007, which he assigned to the State of Israel, Prime Minister's Office.

Mr. Tabor has picked the name "solar trap" for his invention because its purpose is to overcome heat losses by trapping the radiations in a system of mirrors.

The window can be adjusted to follow the course of the sun across the sky, but it achieves the equivalent in a stationary position. This is accomplished through a series of lenses on the outer glass plate that focus the rays at the same points in the trap

no matter what is the position of the sun.

The rays are made to pass from the lenses through a louvered screen and onto a receiver. A large portion of the energy is re-radiated by the receiver. Mirrors on the back of the screen reflect the radiations back to the receiver, a process that is repeated until practically all of the energy is absorbed.

Method Removes Carbon Dioxide

➤ A NEW METHOD of removing carbon dioxide from natural gas by distillation works well regardless of the concentration of the carbon dioxide and without causing any of it to solidify.

In many uses of natural gas, the carbon dioxide content is detrimental to the end use of the gas or to its processing. For example, carbon dioxide tends to solidify at many temperature and pressure conditions during liquefaction of natural gas.

This new removal process, for which Philip E. Bocquet of Ponca City, Okla., received patent No. 2,888,807, is claimed to cut down the "frequently prohibitive" costs of removing especially high concentrations of carbon dioxide by current methods. The patent was assigned to Constock Liquid Methane Corp., New York.

Device Speeds Density Determination for Light Metals

➤ FOUNDRIES will be able to determine the density of light metals such as aluminum and magnesium in 10% of the time it took with previous methods as a result of a newly invented apparatus for measuring the densities of solids.

The apparatus was invented by Samuel Lipson, Hyman Rosenthal, and Anthony Saia, of Philadelphia.

The patent, No. 2,889,703, was assigned to the United States of America as represented by the Secretary of the Army.

In the apparatus, a test specimen is subjected to a partial vacuum to expand its gas content. Then, while at or near room temperature, the specimen is immersed in a tube containing two liquids that do not mix. One of these liquids is lighter than the metal and the other is heavier.

By measuring the weights of both liquids displaced by the specimen, the density of the metal can be quickly calculated.

Non-gelling Tung Oil

➤ EVERY-DAY PAINTS and varnishes that contain tung oil, the secret ingredient in the lacquers of ancient China, are now possible.

A new method for processing tung oil eliminates the possibility of its gelling during cooking, the U. S. Department of Agriculture has reported. The addition of small amounts of zinc resinate controls gelling, the formation of an insoluble, rubber-like mass.

Long recognized as a "super" drying oil, tung oil gives extreme toughness, water resistance, and high gloss to coatings in which it is used. The paints and varnishes made with the new tung oil should be competitive costwise with those using other drying oils, the USDA said. Easy to use and apply, they are described as excellent for interior and exterior surfaces.

The new processing method was developed in cooperation with the Tung Research and Development League. Dr. Leo A. Goldblatt directed the research assisted by Lucien L. Hopper, research fellow for the tung

oil organization. A public service patent, No. 2,829,064, has been granted on the process and is available for licensing to U. S. manufacturers without cost.

Fourfold Improvement Makes Area Lighting More Feasible

➤ AN IMPROVEMENT in electroluminescence promises to bring the phenomenal new form of lighting a step closer to our homes.

Electroluminescence, hailed as the most important lighting discovery since the fluorescent bulb and Edison's lamp, can give paper-thin area lighting that can be made to fit any shape. It might be constructed in wallpaper or made into draperies. At a flick of the switch the draperies and wallpaper will glow to light the home at night.

However, electroluminescent lighting still is weak and too costly to compete with incandescent or fluorescent bulbs. Prof. Georges Destriau, who, in 1936, made the first observation of the phenomena of electroluminescence, has perfected it and increased the light output four times.

In electroluminescence a layer of phosphors is imbedded in two electrically conducting outer layers. When an alternating electric current is sent through the outer layers it sets up an alternating electric field across the phosphor layer. The phosphors are "excited." As they "calm down," they emit their excess energy in the form of soft, glowing light.

The French physicist now proposes that one of the outer layers should oscillate in addition to the electric current alternating. Prof. Destriau achieved a fourfold increase in light output by oscillating an outer electrode.

"No explanation of this increase in light is offered at this time," he reports. Whatever the explanation a fourfold increase in light output is a considerable improvement in electroluminescence and a step forward in making it commercially feasible for homes and offices.

Prof. Destriau, a resident of Cauderan, France, received patent No. 2,901,651. Prof. Destriau assigned the patent to the Westinghouse Electric Corporation, East Pittsburgh, Pa., for which he is a consultant.

Cloth Germproofed By New Process

➤ A WAY of making textiles "durably" mildewproof, germicidal and fungicidal has been patented by Sylvan I. Cohen of Flushing, and Martin S. Frant of Ossining, N. Y.

Textiles have been made mildewproof and germicidal before, the inventors say, but the chemicals were applied in a one-step method that left them water soluble. Consequently the chemicals soon passed out of the textiles and the fabrics lost the resistant properties.

To render the textiles "durably" resistant to mildew, bacteria and fungi, the cloth is soaked in a two-step method, first, in a germ-killing ammonia compound, and second, in a chemical solution called 2-mercaptobenzothiazolate.

The process is simple and the chemicals are inexpensive, the inventors say. And the treated fabric, which may be cotton, retains its properties "for an indefinitely long period of time," the patent says.

The cloth-treating method was granted patent No. 2,899,340 and assigned to Gallowhur Chemical Corporation of New York, N. Y.

Preparing Molybdenum Chlorides

From the N.B.S. Technical News Bulletin, March 1959

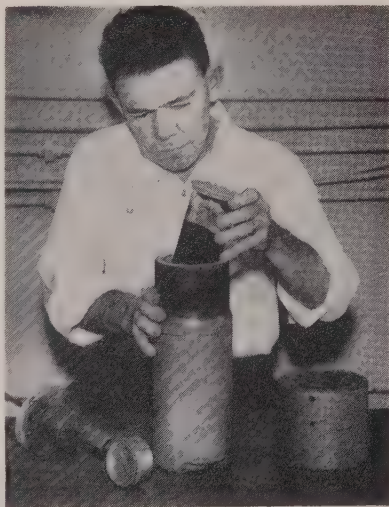
➤ THE TRI- AND TETRACHLORIDES of molybdenum can now be easily prepared by two convenient methods developed at the Bureau of Standards, Washington, in work partially supported by the Army's Springfield Armory. Both laboratory procedures involve reactions with molybdenum pentachloride, which is commercially available. Good yields are obtained under recommended temperature and pressure conditions.

As neither tri- nor tetrachloride can be obtained commercially, laboratory preparation is the only source of these compounds. Previous methods of preparation are inconvenient and time consuming, or else yield an impure product. For example, the reaction between molybdenum pentachloride and hydrogen at a temperature of 250 degrees Centigrade at atmospheric pressure gives a 5-percent yield of the trichloride after a period of 12 hours. With the improved method, lower temperatures and higher pressures are used, producing 97- to 98-percent yields of nearly pure material in 12 hours. Since only a few methods are available for preparing the tetrachloride, the newly developed method provides a valuable source of this low-valent molybdenum compound.

The present methods for both chlorides resulted from experimental studies conducted by D. E. Couch and A. Brenner. The trichloride was prepared by reducing the pentachloride with excess hydrogen. Ordinary high-pressure equipment, a 1-liter steel bomb was used for 50- to 500-gram batches. Molybdenum pentachloride inside the

bomb was treated with hydrogen at pressures from 100 to 1,750 psi while the bomb was heated in an external resistance-type furnace to temperatures ranging from 25 to 275 degrees Centigrade. The trichloride was obtained in satisfactory yields as long as excess hydrogen was present, temperatures were between 125 and 194 degrees Centigrade, and pressures were 100 psi and above.

The tetrachloride was prepared

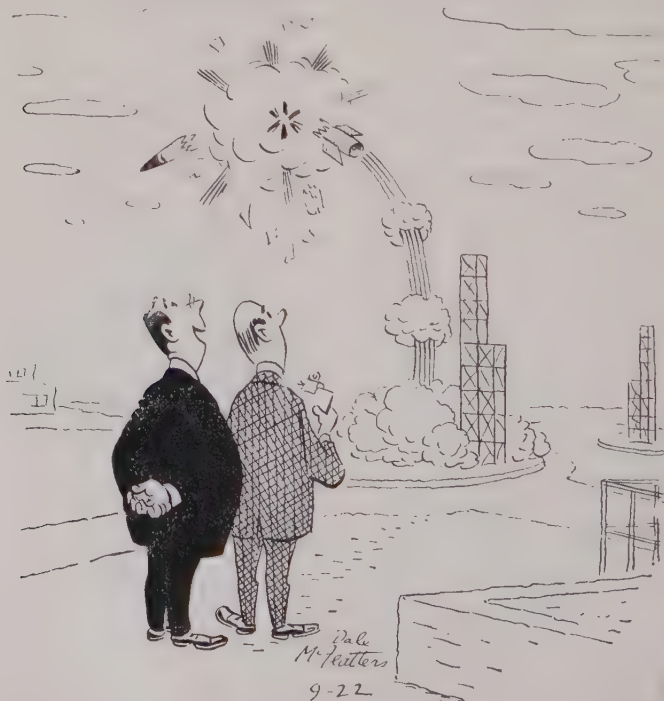


➤ MOLYBDENUM pentachloride (center), used at the National Bureau of Standards as a source of the tri- and tetrachlorides, is placed inside a steel bomb and hydrogenated at the desired pressure. High temperatures are produced in a furnace containing the steel bomb. The tetrachloride is prepared by heating a mixture of the trichloride and pentachloride.

from a finely ground mixture of molybdenum pentachloride and molybdenum trichloride. A glass tube containing about 5 grams of the mixture was sealed in an inert atmosphere and placed inside a steel bomb. Both were then heated in a furnace. A 2:1 mole ratio of pentachloride to trichloride gave the best results with respect to reaction time. At 250 degrees Centigrade, the reaction was about 97 percent complete in 20 hours. The completeness of the reactions was determined by an assay for molybdenum trichloride based on its insolubility in 1:1 hydrochloric acid.

As chemical analysis of these compounds can be deceiving, X-ray diffraction patterns of various molybden-

um chlorides prepared by other methods were compared with those of the tri- and tetrachloride prepared as described above. The X-ray patterns of the trichlorides prepared by hydrogen reduction and by thermal decomposition were identical. The patterns for the tetrachloride obtained from the trichloride-pentachloride reaction showed sharp peaks similar to those obtained with other pure samples of molybdenum tetrachloride. None of the peaks corresponded to those for lower- or higher-valent molybdenum chlorides. Thus, the data confirmed the identity of the reaction products of the newly developed methods, indicating that these methods are satisfactory laboratory techniques.



➤ "Well, back to the Appropriations Committee!"

Science As A Social Goal

Excerpt from an address by Dr. George B. Kistiakowsky, Special Assistant to the President for Science and Technology, at the 25th Anniversary Dinner of the National Association of Science Writers, at Atlantic City, September 16.

➤ SCIENCE is a force pervading our entire social system, altering not only our physical environment but influencing in many subtle ways our social, philosophical, and cultural attitudes. Until very recently, however, much of the science in the United States was inherited — borrowed, as it were — from Europe, where scientific tradition goes back for several centuries.

As you know, prior to 1914 there were only isolated islands of basic research in the United States, and through the '20s and the '30s we depended in a major way on European science. Interest in research was growing in American universities, however, and the explosive growth of technological demands produced by World War II focused attention as nothing else could have done on the relationships between scientific knowledge and technological progress. In the post war period, growth in the rate of technological activity in the United States has been spectacular.

Purely scientific activity has expanded much less rapidly. Even at this late date, the relationship between the two is still not clearly understood. One has more than a suspicion that the average citizen, if he thinks about the matter at all, believes that our technology can be sustained at the needed levels if only sufficient funds are provided and possibly, also, if our schools are turning out "bodies" in adequate numbers. Unfortunately, the matter is not quite so simple as that. To

maintain our rate of over-all progress, our science must grow much faster than, say, the gross national product or any other indicator of over-all economy.

Is our society recognizing this requirement? The answer, regrettably, is no. We cannot have the broad base of scientific activity that is required without first training scientists. This cannot be done on a mass-production basis. Science, like other professions, requires persons of special skills, aptitudes, and temperament. It also requires that such persons shall be willing to subject themselves to the discipline of long and arduous training, coupled with active research experience.

Our national objective should not be the creation of an elite of intellectuals, but rather one of raising and improving the intellectual tone of our whole society, so that scholarly achievement in science as well as in other fields will attract the ablest young minds. At the present time, there is no accurate way of measuring the annual brain power loss in able students who, through lack of interest, lack of funds, or more importantly, through lack of motivation, fail to make full use of their abilities through education. An inquiry along these lines is presently being undertaken by Northwestern University, under a grant from the United States Office of Education. Perhaps it may furnish us some guidance for the future. One

point is clear, however. We cannot achieve a desirable level of scientific activity until there is not only its acceptance by society but a conscious desire to cultivate and encourage intellectual excellence.

I do not suggest that we should emulate the old German bow from the waist and the "Herr Professor Doctor" attitude. On the other hand, neither is it necessary to go the way of H. L. Mencken who held that "The average schoolmaster is and always must be essentially an ass . . ."

How can intellectual excellence become a national goal? We set for ourselves no simple task when we undertake to bring about an improved sense of values for an entire nation. The most direct path is through our educational system, for then we attempt to bring up a whole generation in the way that it should go. About our educational systems and standards there is great diversity and difference of opinion arising out of the firmly established principle of local control of education. Without sacrificing this principle, we can, however, still set for ourselves some broad national standards, against which local efforts can measure themselves. The President's Science Advisory Committee, in its report issued earlier this year, "Education for the Age of Science," concluded that:

. . . Americans should attach greater value to intellectual excellence.

. . . We should do far more than we are now doing to enhance the prestige of the teacher and to provide him with more effective support in his efforts to improve the effectiveness of his teaching.

. . . We should move much further

in the direction of adapting our educational programs to the widely varying competence of students, and seek especially to meet the needs of the most gifted students.

. . . We should improve our scientific education at all levels, attempting to give better understanding of science to the non-scientist as well as to discover and stimulate more individuals who have the talents to become scientists and engineers.

The next question is: Who shall accomplish these things? We certainly do not visualize the Federal Government stepping in and reorganizing the educational systems of the nation. On the other hand, the Government is vitally interested in furthering science and technology and you can't have those without an adequate educational system! Therefore, within the framework of the Federal Government there have been conscious efforts to keep pace with the growing needs of science and technology, as well as education. We have agencies with special missions, such as the Atomic Energy Commission and the Department of Health, Education and Welfare. We have the National Science Foundation, with broad directives for the support and encouragement of basic research and education in the sciences. The office of the Special Assistant to the President for Science and Technology and the President's Science Advisory Committee provide the President with information and advice on science and technology in relation to government policy, with special reference to national security. This body is advisory rather than operational, and its members and panel members are broadly representa-

tive of science and technology outside the Federal Government. The newest organization to join the team is the Federal Council for Science and Technology, established to insure close coordination on policy and planning among Federal agencies whose missions include major scientific activities.

These are some of the steps taken

by the Federal Government to improve its own abilities to guide and assist. The real effort to achieve excellence must be centered in communities all over the United States. A good start in this direction has already been made, largely as the result of the Sputnik. Let's make sure that the momentum continues.

Transistor Tubes of SiC

➤ BETTER electronic tubes that glow blue when working, instead of red, may result from the discovery that silicon carbide is a good source of electrons.

Drs. W. J. Choyke and Lyle Patrick of Westinghouse Research Laboratories, Pittsburgh, Pa., have found that silicon carbide, used as an abrasive in grinding wheels, can emit a heavy stream of electrons when excited.

Dr. Clarence Zener, director of research, speculated that electronic tubes might be built using extremely pure silicon carbide as a replacement for hot cathodes used today. In effect, such a development would be transistorizing the vacuum tube to achieve inherent advantages of both transistor and tube.

Transistors are tiny solid-state devices that can replace vacuum tubes in some jobs. They require little power to operate and hence give off little heat.

In contrast, the ordinary radio tube requires much power for heating its

cathode to red hot temperatures so that electrons will boil off and make the tube work. This large amount of power makes the tube less efficient than the transistor. The heat given off becomes a serious handicap in some cases.

By replacing the hot cathode structure with a cool unit of pure silicon carbide, little power would be required for the tube and little heat would be given off. Through this idea, a better and less complex TV picture tube might be developed.

When enough voltage is applied at a junction point on the pure silicon carbide, the material's normal electrical resistance breaks down. Small blue spots of light suddenly appear near the junction. Electrons escape from these bright, light-emitting spots, which are only 50 millionths of an inch in diameter. The spots have yielded currents up to one millionth of an ampere. This density is "quite comparable" with that from the cathode of a typical electronic tube, Dr. Zener said.

✓ Answers to CHEMISTRY QUIZ on page 32. ✓

A - 3; B - 4; C - 3; D - 1; E - 3.

New Plastic Good at 15,000° F.

➤ A TOTALLY new material capable of protecting man, animals or delicate instruments in the awesome flight through space and re-entry into the earth's atmosphere has been devel-

oped by the General Electric Company's Missile and Space Vehicle Department.

The material was developed as a heat shield for nose cones sent into



➤ SUPERSONIC FLAME at more than 5,000°F. is blasted at a sample of the new nose cone protective material developed by General Electric at its Missile and Space Vehicle Laboratory in Philadelphia. The scientist shown in this photograph wears dark glasses to protect his eyes from the white hot flame and ear coverings to protect his ears from the deafening sound of the flame. The material has withstood temperatures of more than 15,000 degrees, greater than the surface temperature of the sun.

space with invaluable cargoes to protect them against the tortures of supersonic speeds, searing heat and rigorous mechanical forces encountered in re-entry flight.

Space shields made from the new material can be produced for a fraction of the cost of the protective coatings currently used on test flights into space.

The material, an organic plastic substance, has undergone many tests in preparation for space flights expected to be conducted within the next few months.

Dr. Leo Steg, manager of General Electric's Aerosciences Laboratory, said space shields of the new material can be produced in relatively short time, compared to the weeks-long production schedule for current nose cone protectors.

Production simplifications and cost saving will prove a decided advantage to the U. S. Government and to the taxpayer, according to Dr. Steg.

"The protective qualities of this material should be of special interest to America's astronauts who will rely on an inch or two of material expected to shield them from extremely high temperatures on the return home from space — a voyage of discovery undreamed of less than five years ago."

The two fabrication systems now in general use are more complicated. In

one, the protective material is molded in high pressure presses. In the other, miles of special impregnated tape is wound around nose cones as a protective outer coating.

Laminated and high pressure molded phenolic materials now used as nose cone thermal shields are difficult and costly to fabricate. The new material differs radically from these previously known heat protective materials in that relatively inexpensive, easy to procure equipment can be used for its manufacture.

The basic materials are blended and heated in temperature controlled ovens, mixed to the proper consistency, subjected to an air removal process, and poured into molds.

Dr. Steg said material molded in the new simplified process could be designed for the *specific* job to be done.

"It can be made elastic, flexible or hard," he said. "In all variations, it possesses excellent heat protective qualities."

The space shield material has been successfully tested in high temperature facilities. In one such test, supersonic flame of more than 5,000 degrees is blasted at the material. In another, the material is subjected to temperatures of more than twice the surface temperature of the sun, as great as man has ever created on this earth for sustained periods.

On the Back Cover

► OUR BACK COVER shows part of an "H.F." Alkylation Unit of the Derby Refining Company, at Wichita, Kas., which is designed to yield a 100 octane leaded alkylate for use in the

production of high octane motor fuel.

Flexibility of design allows the Unit to process either a C_3 - C_4 or a pure C_4 olefinic charge from a "cat cracker," together with isobutane.

Chemistry Comments

Interesting facts in the chemical world.

- Ultra-pure silicon is a basic material used in making solid state devices, or semiconductors, such as transistors and rectifiers.
- Because of the volatility of zinc in comparison with iron and nickel, the alloys of these metals cannot be conveniently prepared by melting.
- Iodine-131, used primarily in medical research, has a radioactive half-life of approximately eight days and decays to stable Xenon-131.
- In 1958, more than \$70,000,000 worth of uranium came from Saskatchewan.
- Copper, as an alloying element, serves to retard corrosion in some steels and is usually added in metallic form.
- Gypsum is a mineral with unusual fire-resistive qualities, for it slowly releases water of crystallization when subjected to high temperatures.
- Antiparticles, according to nuclear physicists, are building blocks in a bizarre state of matter forming a kind of "mirror image" of the ordinary matter of which the earth is made.
- The tracks of high energy atomic particles such as pi mesons are recorded by special film in the University of California's new "bubble chamber."
- Aluminum is the metal most utilized for missiles and missile equipment.
- The gold output of South Africa was 17,154,000 ounces in 1958.
- The production of uranium oxide in the free world is running ahead of requirements.
- Iodine was first isolated from burnt seaweed in 1811.
- Chemists in the U. S. spend an average of 16½ hours a week in scientific communications, and 6.7 hours per week in business communication.
- Hydrogen sulfide, the source of the classic rotten egg smell, and ammonia are among compounds present in the characteristic beef aroma.
- It was not until 1952 that morphine was synthesized, confirming its chemical structure.
- France is the fourth country to use electricity obtained from nuclear sources, the others being the United Kingdom, the U. S. and the USSR.
- Opium throughout history has been the most widely used analgesic for severe pain. Its value is recorded in Babylonian clay tablets and the Ebers Papyrus as well as in the writings of the Greeks and Romans.
- Gasoline consumption in the U. S. hit a record peak of 59,154,000,000 gallons in 1958, an increase of 1,750,000,000 gallons over 1957.
- Boron is alloyed with steel to enhance the hardening properties of the finished product.

Book Condensations

PRINCIPLES OF PHYSICAL CHEMISTRY — William H. Hamill and Russell R. Williams, Jr. — *Prentice-Hall*, 607 p., illus., \$8.75. Two-semester introductory course, covering chemical thermodynamics, chemical equilibrium, electrochemistry, photochemistry, and radiation chemistry.

ION EXCHANGE: A Laboratory Manual — J. E. Salmon and D. K. Hale — *Academic*, 136 p., illus., \$5. Introductory course presenting the fundamental principles and offering guidance in practical problems arising in the application of ion exchange.

AROMATIC SUBSTITUTION: Nitration and Halogenation — P. B. D. de la Mare and J. H. Ridd — *Academic*, 252 p., \$9. This Monograph discusses in detail two of the most important electrophilic aromatic substitutions. Each chapter followed by list of references.

A SHORT COURSE IN ORGANIC CHEMISTRY — Harold Hart and Robert D. Schuetz — *Houghton*, 2nd ed., 346 p., illus., \$6. Written for students in agriculture, medicine, and other groups requiring less than the traditional year's course.

ELECTROLYTE SOLUTIONS: The Measurement and Interpretation of Conductance, Chemical Potential and Diffusion in Solutions of Simple Electrolytes — R. A. Robinson and R. H. Stokes — *Academic*, 2nd ed., 559 p., illus., \$11.50. Revision includes new experimental and theoretical developments, and recent work on conductance of non-aqueous solvents.

CHEMISTRY IN THE LABORATORY — Jay E. Taylor and John R. Demuth — *Burgess*, 2nd ed., 242 p., illus. by

C. C. Taylor, paper, \$3.75. Describes 36 experiments, ranging from Bunsen burner to formal qualitative analysis scheme.

PRINCIPLES OF PHYSICAL CHEMISTRY — William H. Hamill and Russell R. Williams, Jr. — *Prentice-Hall*, 607 p., illus., \$8.75. Intended for a two-semester introductory course in physical chemistry, covering the complete range of material from classical to modern.

THE CHEMISTRY OF ORGANIC COMPOUNDS: A Year's Course in Organic Chemistry — James Bryant Conant and Albert Harold Blatt — *Macmillan*, 4th ed., 652 p., illus., \$7.75. First-year course rewritten in the light of recent developments in chemistry.

VACATIONS ABROAD, Vol. XI, 1959 — *Unesco (N.Y.)*, 11th ed., 180 p., paper, \$1.25. Directory of vacation activities, courses and seminars, organized in more than 75 countries by about 740 institutions, to enable persons to become better acquainted with the civilizations and cultures of other countries.

GENERAL CHEMISTRY: A Systematic Approach — Harry H. Sisler, Calvin A. VanderWerf and Arthur W. Davidson — *Macmillan*, 2nd ed., 851 p., illus., \$7.95. Text for chemistry and engineering students, offering a balanced foundation in general chemistry on a logical, inductive basis.

AN INTRODUCTION TO CHEMICAL ENGINEERING — Charles E. Littlejohn and George F. Meenaghan — *Reinhold*, 271 p., \$7.80. Beginning text explaining some of the fundamentals upon which chemical engineering theory is based.

New Revised Edition Published October 1

Total Copies 72,000

THE CHEMICAL ELEMENTS

by Helen Miles Davis

Revisions by Dr. Glenn T. Seaborg, Nobel Prize Winner

THE THRILLING STORY OF MAN'S DISCOVERY OF THE BUILDING BLOCKS OF THE PHYSICAL UNIVERSE . . .

Completely up-to-date, fully indexed, invaluable for reference. An essential, highly readable handbook for every student, teacher, professional chemist! This handbook may be purchased with funds under Title 3 of the National Defense Education Act.

This is the authoritative story of their discovery and all that is known of their construction, so simply told that anyone may understand it.

The fascinating array of the building blocks of matter is fully covered from H for hydrogen to those elements discovered in the atomic era, numbered 93 to 102. And the story of each element, its properties, sources of the most important varieties (isotopes), characteristic compounds, and place in periodic tables appears here in a clear and readily understandable form.

SCIENCE SERVICE — 1719 N St., N.W. — Washington 6, D. C.

Send me _____ copies of "The Chemical Elements" at the rate of 10 or more at 50 cents each, less than 10 copies 55 cents each, postpaid.

() \$_____ enclosed () Bill me

Name _____

Address _____

City, Zone, State _____

10-59

Start the new school year with Group Subscription to CHEMISTRY

If you are a TEACHER, CLUB LEADER, GROUP LEADER, order a CHEMISTRY bundle. Science Service offers schools, industries, and science organizations the CHEMISTRY BUNDLE ORDER PLAN for orders of 10 or more copies to the same address.

Special quantity rate is \$2.90 for the complete volume, September through April, a saving of more than 25%. This makes it possible for every student or club member to have this valuable reference magazine. Front cover to back cover, CHEMISTRY explains the chemical world of today and what to look forward to tomorrow!

Use this convenient coupon or write us a letter

BUNDLE SERVICE ORDER BLANK (10 OR MORE COPIES)

TO CHEMISTRY - 1719 N. ST. N. W. - WASHINGTON 6, D. C.

Please send me Copies of CHEMISTRY in one bundle each month, September through May.

1 year at \$2.90 each subscription in lots of 10 or more to the same address.

☐ Remittance enclosed

☐ Please bill me

Name _____

Address _____

City, Zone, State _____

